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DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. IX. No. 106. OCTOBER, 1928. PRICE 1s. NET

EARLY NORSE CARVING FROM GREENLAND
(see page 305)

CHIEF CONTENTS.

	Pages
Editorial Notes	303
Excavations in Greenland ...	305
The Chemistry of Stars ...	310
A Seashore Curiosity	314
Mount Athos Today	315
Correspondence	318
A Sidelight on Geography ...	319
Male Birds—A Surplus? ...	322
Searching for Salt	325
The British Association... ...	328
Book Reviews	331

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DISCOVERY

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Editorial Notes.

The first public transmission of wireless pictures is to begin this month, when the British Broadcasting Corporation will make a short experiment daily from the Daventry 5 XX station. At first this new service is to take place outside existing programme hours, but later, if it appears that there is a sufficient demand, it will be included in the regular programmes. A system known as the Fultograph will be used, which resembles the "telectrograph" invented by Mr. Thorne Baker and first used nearly twenty years ago by a London newspaper. At that time the photographs sent by this machine from Manchester to London passed over a telegraph wire, but the later development and application of wireless to the method has not altered its essential principle. The B.B.C., in fact, have wisely reminded the public that methods of transmitting and receiving still pictures by wireless should not be confused with television—a warning by no means superfluous in view of the recklessness with which even the leading newspapers continue to confuse these terms. Television, of course, is the seeing by mechanical means of living objects or scenes taking place at a distance from the observer, something quite distinct from the recording of a still picture on an apparatus which by analogy is not unlike a dictaphone. The material of each still picture transmission will consist of "a selection from several subjects." Presumably the most popular pictures should be those connected with sporting events, of which the results have been broadcast vocally an hour or two before.

* * * * *

Television is the subject in the official statements of a further reference which cannot be regarded as entirely satisfactory. The first announcement, dated 8th September, that "no practical demonstration of television has yet been made to the B.B.C.", was later qualified in view of "current rumours" as follows: "The B.B.C. wishes to make it plain that it has not so far been approached with apparatus of so practical a nature as, in the opinion of the Corporation, to make television possible on a service basis." Presumably the current rumours concerned Mr. John Baird's press statement that his company is "quite ready" to begin television broadcasting, and his reported surprise at the official attitude. Without questioning in any way this inventor's integrity, we cannot help feeling that an impartial inquiry is called for. Either the B.B.C. is misinformed or the position of Mr. Baird's invention has been exaggerated. We published in *Discovery* his first article, in April, 1925, and have since devoted considerable space to the subject. It is therefore in the friendliest spirit that we suggest Mr. Baird should now define his position—at a juncture which may well be of historic importance in television—or at least he should censor rigorously the output of certain journalists to whom any want of confidence in his invention is largely due. Meanwhile, a demonstration of the General Electric Company's rival apparatus has been given to the Press in America, where a play was successfully "televised" over a distance of eight miles.

* * * * *

The theory lately advanced in *Discovery* that there may be a surplus male bird population does not meet with the agreement of Mr. E. M. Nicholson, the ornithologist to whose views on territory our correspondent related his suggestion. Mr. Nicholson admits, however, that it is one of those questions which has been neglected for more obvious studies, and that it should be capable of solution by co-operative work on the part of bird observers. Elsewhere in this issue he proposes a method that hinges on the readiness with which birds of either sex replace a mate lost during the breeding season. This factor seems to indicate

a large and mobile non-breeding population always ready to step into gaps, and one way of getting evidence, therefore, would be to catch the hen or cock at selected nests and see how often the operation could be repeated. This might be done with starlings or great titmice—whose sexes are distinguishable in the hand—and in Mr. Nicholson's opinion the value of the data would certainly outweigh the inconvenience to the birds. We hope to publish further details of this problem in order next spring to discover a satisfactory answer.

* * * * *

We remarked recently on the exemption of scientific films from Customs duty, but it appears from a first experience that the new procedure is extremely cumbersome. The admission of a film may be allowed free of duty if its purpose is vouched for by the Royal Society, which has, however, to issue its certificate not to the society applying for exemption from duty but to the Customs authorities. Accordingly, the secretary of the International Congress of Orientalists wrote to the Customs authorities, on behalf of Dr. Rathjens of Hamburg, who desired to illustrate his lecture to the Congress with a film. More than a week passed before the arrival of a reply, which asked the length of the film, whether positive or negative, and other details scarcely relevant if the film was to be exempt from duty. A further letter to the Customs authorities produced more complications, including the proposal that in view of the short time before the meeting the duty should be deposited pending the Royal Society's attention to the matter; it was added that the Customs "Commissioners *understand* that the duty on a positive film of this length is *about* £31 10s." (the italics are ours). Whatever views are held on the merits and otherwise of a duty, it is surely reasonable to expect that the authorities concerned should be able to specify precisely the extent of their charge. To cut a long story short—it was given in full by Professor J. L. Myres in an admirable letter to *The Times* on 4th September—the Congress took place without the film, and it was necessary at the last moment to withdraw Dr. Rathjens' paper from the proceedings. To say the least, this is hardly an encouraging precedent.

* * * * *

On another page appears a short account of a few of the most interesting papers delivered to the British Association. The authors of papers addressed to the Association make no attempt to popularize their contents; the increased public interest in the meetings being entirely due to an increased appreciation of the aims of research, and a desire to know more than the basic facts of the various branches of science. In 1831, when the Association held its first meeting in York, the leading newspapers thought fit to ridicule the idea of the general public taking any interest in science; but what newspaper to-day would reject the "publicity value" of a new aspect of the theory of evolution or of a new scare about the possibilities of the "death ray"? The manner of presentation of the results of scientific research has, indeed, become a matter of serious concern to those who consider the interests both of science and of the public. Glaring headlines may often bring more ridicule than praise on the results of brilliant research; and the flow of journalistic language may mould as well as distort the popular conception of scientific issues which affect the welfare of the public.

* * * * *

The diary of Philipp von Neumann, an Austrian diplomat who held appointments in England from 1814 to 1844, has been discovered by General Sir George Aston. Extracts are appearing as we write in *The Times*, before publication by Messrs. Philip Alan. The general impression afforded is how little social conventions have changed in a hundred years by contrast with the revolution in intellectual conceptions. We can sympathize with a comment that the company "were regaled with a dinner and a family concert afterwards which upset our stomachs as much as our ears," but there is an almost mediaeval picture in the entry for 14th October, 1819:—

> A very curious case was heard to-day at the King's Bench. A Mr. Carlile had published a work by Thomas Faine proving that the Bible was filled with absurdities, obscenities, and other scandalous matter. He had cited as witnesses the Archbishop of Canterbury, the Chief Rabbi, and the Astronomer Royal, Mr. Bond, in order to examine them, and above all to get the last to explain how it was possible for Joshua to make the sun stand still before Jericho. The scandal caused by this man during the trial so affected the jury that they condemned him without hesitation.

* * * * *

The Radio Research Board has just issued its report on wireless observations made during the solar eclipse on 29th June last year. These show that the eclipse produced a very definite effect on the properties of the ionized layer of the atmosphere responsible for deflecting wireless waves of 300-400 metres back to the ground. The most striking effect was the large increase in the intensity of the downcoming ray, which was detected at both near and distant receiving stations. The results as a whole seem to suggest that the more southerly receiving stations experienced the maximum eclipse influence a little earlier than the northern stations.

The Bishop's See of Ancient Greenland.

By Poul Nörlund.

The National Museum, Copenhagen.

During the summer Professor Nörlund has excavated the remains of the thirteenth-century bishopric in Greenland. A bishop's skeleton with gold ring and carved staff—the first works of art brought to light from these Norse ruins—are among the important discoveries.

In the western European countries, which suffered from the Viking invasions of long ago, people are often amused and occasionally perhaps amazed at the unblushing pride which we Scandinavians take in our wild and savage forefathers. For truth to tell, the majority of them, whenever they appeared, brought trouble or even disaster to peaceful folks. But a few figures stand out from the bloody horde, not because of a greater chivalry or humanity, but because, in addition to the romantic ferocity of their history, there was also about them a certain cultural air of a particularly magnificent kind.

SITE OF THE EXCAVATIONS.
General view of the settlement at Igaliko, formerly the site of the cathedral and Bishop's see, where the new excavations were made.

Such a figure, standing head and shoulders above the rest, was Eric the Red, the discoverer and colonizer of Greenland. Of his grim character we have more than sufficient evidence. For manslaughter in his youth he left Norway with his father and set out for Iceland. For a second homicide he was sentenced in Iceland to banishment from his adopted country. As an outcast he set out once more upon a voyage of discovery across the dangerous western ocean, and found here—hidden behind the drifting polar ice-belt—the smiling Greenland fjords, which offered to frugal peasants conditions equally as good as those in many parts of Iceland or northern Norway. He was not one of those discoverers who were satisfied by merely seeing a country once, and then leaving for ever what they had found. He brought settlers from Iceland and established in Greenland quite a little "kingdom" of his own, which continued for nearly five hundred years (approximately A.D. 1000-1500) as a distant outpost of European civilization, first as an independent republic, and later as a feudal state under Norway.

About the time when the southern Europeans discovered America, however, these Norsemen lost touch with Europe, and after the lapse of some time they must have perished. The population died out, the houses collapsed, and grass and willow undergrowth covered the ruins. Eskimo tribes settled on the points and promontories, but inside the fjords, where the Norsemen lived, everything became silent and still. For centuries all human life stagnated, and a wanderer visiting these parts might well walk for days without finding any signs of life, other than a frightened, nervously cackling grouse or an eagle circling in unfathomable silence over his head.

The remains of Norse habitations are still to be discovered almost everywhere in these parts. It sometimes happens that traces of a path are found, leading straight up to the ruins of a stone house. This path was made by the peasants walking for centuries along it upon their daily journeys to and from the well, the pond, or the landing stage, and even the ages that have elapsed since then have not succeeded in effacing it entirely. The grass upon it is shorter and thicker and of another colour. The ruins are well hidden by the undergrowth, and they are easily missed upon a first search; the surest signpost is usually found in the fresh green of a former midden, gleaming brightly from the brown grey moors.

In fact, in the firths of southern Greenland, where all human activity now has been dead for centuries, there is hardly a spot which the old-time peasants did not try to turn to account. Every valley had its farm, every hill slope its sheep fold. Even the smallest rocky islet, and tracts of land stretching right in under

the fringe of the inland ice were utilized. The country was really " fully inhabited," as they put it in the old reports. Thus there is an example of the culture of the Middle Ages hidden away here in South Greenland, more undisturbed than would be possible to find almost anywhere else in Europe, an exceptionally fascinating field of research for archaeologists.

The Danish State, represented by the Commission for Scientific Investigation in Greenland, has sent a number of expeditions there to find and examine these northern remains, and the last two of them I had the honour of leading myself.

A Prosperous Colony.

It might perhaps be assumed that necessarily a poor and primitive form of culture must be found in these distant places, with hardly anything of interest to the general cultural history of Europe. But this assumption has proved somewhat erroneous. During our expedition to Herjolfsness in 1921 we had found a large number of dresses of the Middle Ages, which might possibly be called poor, in that they were woven of simple wool, as well as the Greenland women were able to weave them, but which in their cut and style are faithful copies of the European fashions of that time. The hoods (chaperons) with the long tail hanging from the back of the head, or the long ample skirts, which with but little difference were used by both sexes, are almost the only everyday dresses of the European Middle Ages now extant, and if only for this reason, therefore, are naturally of considerable interest.

Our finds at Herjolfsness gave us some insight into the tragic end of these Norsemen, for anthropologists have been able to read from the skeletons found that they were those of a population greatly degenerated by intermarriage and malnutrition. There is something very touching about the fate that met these brave and long suffering colonists, who, after being left entirely to themselves, slowly perished, either of actual hunger or by the arrows of the Eskimo natives. But in spite of their tragic end, it is important to recall the prosperous times which these colonies also enjoyed ; and to throw some light on this period, we turned our attentions during our latest expedition to the old see of the Greenland bishops at Gardar (now Igaliko).

Christianity came to Greenland in the first generation after the Icelanders settled there. Eric the Red certainly was a steadfast heathen, but his own son Leif brought missionaries in his ship from the British Isles, and Eric's wife is said to have built the first Christian church in Greenland. For a whole century or more they lived without any regular Christian organization. The peasants, who had built churches usually upon their own farms, as was the case in Iceland, attended to the priestly duties themselves. This practice was a relic of heathen times when the most important farmer was himself the sacrificial priest and the representative of the Godhead. In order, however, to maintain the faith over successive generations, it became essential to establish an independent bishopric in Greenland, and it is a tribute to the Greenlanders' own cultural virility, that they undertook the establishment of this bishopric themselves. It was not a task forced upon them by others, but in Scandinavia their request was soon granted, and for centuries the Norwegian church sent over bishops—and among them highly distinguished prelates—to this little episcopal see which, with its fifteen churches and 2,000 to 3,000 people, formed hardly more than a tenth part of a normal diocese. The first bishop, Arnald, went to Greenland in 1126, and was given a dwelling at Gardar, where the peasants had set aside one of the best farms in the settlement as the " bishop's palace." This place is one of the few where modern Greenlanders have also settled.

Our first impression, on arriving there, was one of great disappointment. Where were the many ruins, which we had heard about from former visitors? We saw now only huts of the usual type used by modern Greenlanders. Alas ! we soon found the explanation ; the beautiful, regular stones of which the huts were built, had all been taken from the old ruins. For 150 years the inhabitants have been pilfering stone from the Norsemen's houses, and now every part of the low walls standing above ground level has disappeared. Some of the Eskimo huts

ESKIMO FARMERS TO-DAY.
Hand threshing is here seen in progress, the modern inhabitants using the site of the ancient bishop's farm for their operations.

certainly looked a little peculiar. There were, for example, a couple of outhouses for winter fodder for the domestic animals, of which the roof consisted of a single enormous block of stone, some five tons in weight. (See photograph.) Now this is not the sort of work that the modern Greenlander would care to tackle, as everyone knows who has had anything to do with him. It was then discovered that these outhouses originally had formed the entrance portals of Norse dwelling houses. The roof was simply the top stone of the portal, and the Greenlanders had merely added a wall at either end of the passage to make what, to their ideas, was an easily made and roomy tool-and-provision shed. A better example of the difference between now and then—between the natives of small stature and the virile brawny fellows who lived there in the Middle Ages—could hardly be found than that of an old porch which originally connected

THE RUINS OF THE CATHEDRAL.

Excavation in some turnip fields revealed the cathedral walls, which served as the foundation for modern walls used to divide one allotment from the next.

two rooms in a cowshed now forming a whole house for the modern Eskimo.

During the summer we excavated a large number of ruins, as fortunately the natives had been unable to remove the foundation stones. It was a surprisingly comprehensive and ambitious lay-out when we remember how far away from civilization it all was. The cathedral, the first building to be cleared, must not, of course, be compared with those in Europe or even in Scandinavia, for in comparison it dwindles into a mere country church. After all, it is possible in that way to make almost anything appear small. The one thing to do is to find the right measure, and here we find one ready to hand. Iceland was the mother country of the Greenland colonists, and thus in the Saga island we find the best measure with which

ANCIENT AND MODERN STONEWORK.

Porch covered with a stone of five tons weight in an ancient cowshed, now used as a bivouac by the modern Greenlanders.

to appraise properly what we find in Greenland. It is seen, surprising as it may be, that the old Greenland parish churches, or "peasant" churches, which have been excavated during the last generation, are considerably *larger* than their Icelandic equivalents. And, from what we know, the bishops' churches in Iceland during the Middle Ages seem to have been in no way larger or better than that in Greenland, although the two Icelandic bishops were the spiritual heads of over 330 churches.

So it was with the bishop's "palace"—the actual dwelling used by the bishop and his retainers. We found it, after careful search, hidden away in the Greenlanders' turnip fields, where the former walls served as the foundation of the stone walls now dividing one small allotment from the next. Each single room thus forms a separate little field all to itself. Of these rooms I will mention only the reception hall, where great festivals were held on such occasions as the gathering for the annual parliamentary meetings, which took place upon the Gardar plain, and for the important church celebrations, especially that of Christmas. Christmas even from heathen times was celebrated as a solstitial festival, for in mid-winter the sun rises above the mountains for a couple of hours only, and the festival marked the date from which the days were about to lengthen again.

The bishop's reception hall measured 16.7 by 7.8 metres, or about 130 square metres. This is quite a respectable room even to our ideas; but only by searching the old historical records can we realize how many guests it was possible to regale in a room of this size. Here, again, it is the Icelandic comparison that we use as a measure. One of the most powerful men in Iceland's famous Middle Ages was

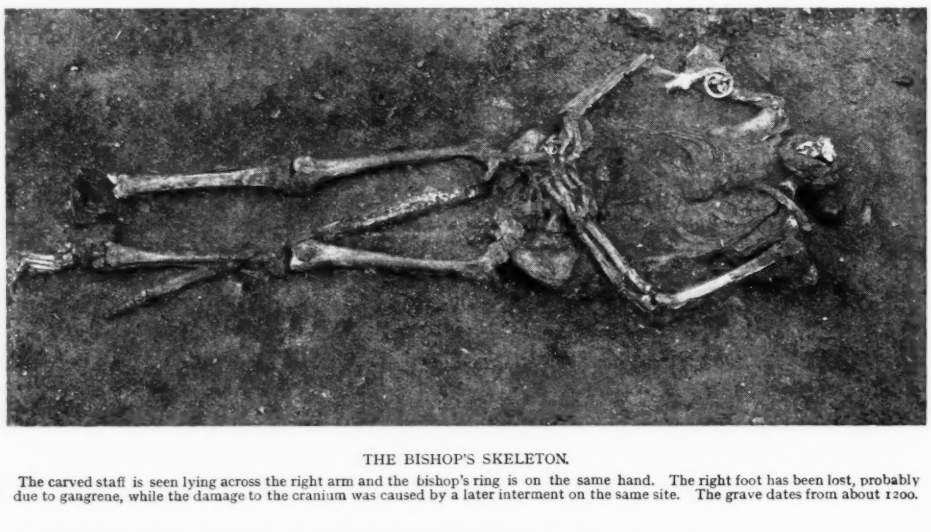
one Gissur Thorvaldsen, who was appointed earl of his native island by the Norwegian king. In 1253 Gissur celebrated upon his farm at Flugumyre in north Iceland his son's marriage with a daughter of another great Icelander, one Sturla Thordsen. The wedding was made grimly notorious by the murderous fire which concluded the ceremonies, and in which twenty-five people perished, the bridegroom among them.

The Bishop's Hall.

The Saga describes this wedding in detail, referring to it as the most magnificent ever held in the Iceland of that time. In the hall more than 200 people sat down to eat, in six rows one behind the other, and we are fortunate enough to learn the exact measurements of this drinking hall, presumably because they seemed so enormous to the story-teller himself. In modern measure it was 68 square metres, that is to say, only a little more than half as large as the Gardar Bishop's Hall. In Trondhjem (Norway) the Norwegian Archbishops' Festival Hall (Hall of Knights) is still preserved. It is only 3 metres longer and 1½ metres broader than that of Gardar.

Of the extent of the farming upon the bishop's land we may also draw our own conclusions from the ruins, and we are bound to admit that it must have been considerable. Besides a number of small sheds for sheep and goats, horses and pigs, there were two cowsheds, the largest being 75 metres long, and the two together being large enough to house several hundred cows! We must assume that these sheds were not built bigger than circumstances required; but it is certainly puzzling to discover whence was procured the winter fodder to feed all these animals. There was certainly an enclosed home field (tun) of about forty acres, which in relation to Icelandic proportions is no mean size. The cattle were not allowed to graze here in summer time, but the greater part of this field is now quite barren and the whole does not yield many cartloads of hay. A couple of meadows have also been walled in. In all, the enclosing walls are about 1,200 metres in length, all of them low, but very strong, being at least one metre thick and obviously the result of the expenditure of much labour and time.

The ruins on the Gardar Plain tell their own story plainly enough, broken and uncared for though they be. They tell us of a strong and virile people, full of life and energy and ready for any work that came to hand. The bishop's farmhands did not lounge about at a loose end the whole summer through, while the cattle out grazing could be tended by few. This is proved by the numerous walrus' skulls, which came to light wherever we began to dig. The skulls are reminders of the great summer journeys which took the hunters often hundreds of miles away, northwards along the west coast of Greenland, or around the southern point to the dangerous ice-bound east coast, seeking for the big sea creatures from which they procured valuable trade articles. These were so much in demand in Europe that European merchants were even tempted to make the journey to Greenland to buy them. Soft furs and heavy skins were obtained, and above all the white tusks of the walrus and narwhale which were sold all over northern Europe as ivory. Even Peter's Pence to the Pope were then paid by the Greenlanders in walrus tusk.



THE BISHOP'S SKELETON.

The carved staff is seen lying across the right arm and the bishop's ring is on the same hand. The right foot has been lost, probably due to gangrene, while the damage to the cranium was caused by a later interment on the same site. The grave dates from about 1200.

I have related something of the bishop's palace and of the cathedral, the background of the bishops' activities in this far off country. Of the bishops themselves little is known beyond their names, and occasionally from historical records the dates when they came out and when they returned home. It was therefore a great satisfaction to us when we succeeded in finding a bishop's grave in the cathedral. It was the most important event of the summer's research work.

Among the pebbles under the floor of the North Chapel we discovered one day a little piece of bone with an ornamental design carved upon it, and it aroused a definite hope among us all. For over two days excavations were carried on extremely slowly and carefully; it was important that nothing should be destroyed or damaged. From hour to hour the carved piece gradually emerged, until it began at length

THE BISHOP'S GRAVE.
This view of the northern chapel at Gardar shows the bishop's skeleton in the position of its discovery. No coffin protected the corpse.

to take a curved shape. We knew then that it really was the spiral curve of a bishop's staff which we had found, carved in walrus tusk, the most valuable material in the country. When the surrounding debris was finally removed and the crook lay there in all its gleaming dark-brown beauty, with its characteristic carvings, we could not but feel a certain reverent awe. For the first time a work of art had been brought to light from the old Norse ruins in Greenland.

The further uncovering of the fragile skeleton to which the staff had belonged was hardly less difficult. The exciting question was whether the bishop's ring was also preserved. Sure enough, it encircled still the ring finger of his right hand, where it had been placed by the Norwegian archbishop at his solemn consecration in Trondhjem Cathedral. Both the gold ring and the carvings on the staff indicate the time as about 1200, but just at the beginning of the thirteenth century several bishops followed one another quickly in succession, so it would be difficult to say with any degree of certainty who it was that lay buried here. He must remain anonymous as "the Bishop of Greenland 700 years ago," and so will we reverence his memory. Far too many of his clerical brethren left for home again after only a short time in office, or did not even venture to come out at all! Conditions were naturally not exactly inviting for a spoilt prelate, but here was one of them who had remained with his congregation.

THE BISHOP'S STAFF.
Delicately carved in walrus tusk, the most valuable material in the country.

The bishopric and the trade interests were the only two links which bound Greenland to European civilization. Thus was forged a fine chain which reached right down to Rome. The bishops travelled all the way down there after their appointment, and so even the Pope himself received some knowledge of the conditions existing in this his most distant diocese. It was, however, a limited understanding which was acquired, for example, in 1270 the northern countries received a flat refusal to their application to be allowed to use a substitute for grape wine and wheat flour for altar wine and oblations. At the Papal Court they appeared unable to grasp the fact that both Iceland and Greenland lay so far away that sheer necessity made them tolerate substitutes if the Sacrament was to be given at all.

In 1377 the last bishop who resided in Greenland died. For yet another 150 years the Popes continued to appoint new bishops of Gardar, but they were only titular bishops, who never visited Greenland nor attempted to do so. It was one of the great faults of the Catholic Church at that time, that such abuses could take place. But the evident reluctance of the bishops is one of the first evidences of the critical condition of the Norsemen in Greenland; just as their presence out there had been the strongest expression of the importance of the settlement.

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The Chemistry of the Stars.

By A. Vibert Douglas, Ph.D.

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New facts discovered about the chemistry of the stars have altered former ideas, and the whole question of stellar evolution is at present under reconsideration. Theories which seemed tenable two or three years ago are either abandoned or regarded with caution.

THE chemistry of the stars is fortunately not very complex. By far the greater proportion of the matter in the universe is at tremendously high temperatures. According to a recent estimate, ninety per cent of all matter is at a temperature exceeding 1,000,000° centigrade. Here the physical conditions are comparatively simple and molecules are unknown, for the atoms themselves are disrupted into free electrons, protons, and atomic nuclei, all moving about with tremendous velocities in a medium literally filled to bursting-point with penetrating radiation. This is the picture of the interior of a star.

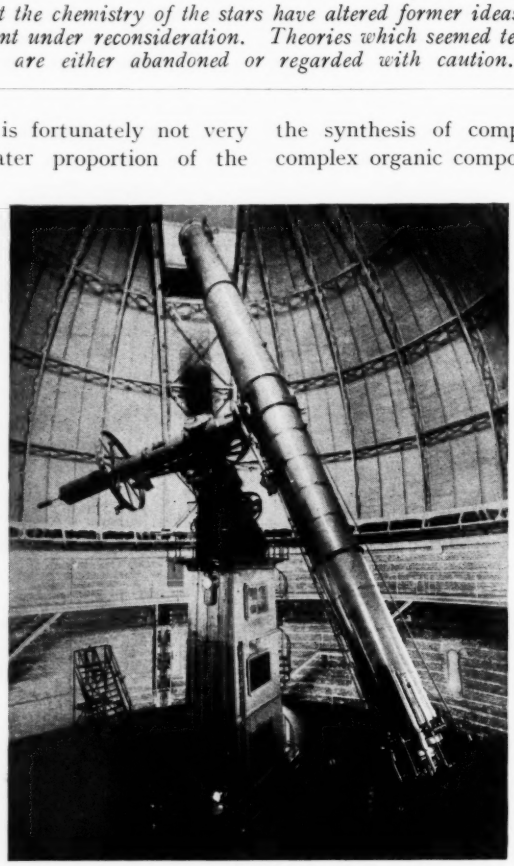


FIG. 1.

FORTY-INCH REFRACTOR.

This giant telescope of Yerkes Observatory, whose lens is 40 inches in diameter, is 62 feet in length and weighs, with its counterbalancing weights and all the moving parts, about 20 tons. The dome is 90 feet in diameter.

Photograph by Prof. F. E. Ross, Yerkes Observatory.

At more moderate temperatures, perhaps 20,000°, most of the atomic nuclei have captured a sufficient number of electrons almost to balance their positive electrostatic charges, while at somewhat lower temperatures most of the atoms are fully equipped with their requisite numbers of orbital electrons and at about 12,000° the linking together of atoms to form simple molecules commences. Down even to the temperature of 3,000°, however, the tendency to aggregate into molecules is not very marked, and only about a dozen chemical compounds are recognized. This is the state of affairs in the atmospheres of the stars.

Thus it is evident that the chemical conditions which we have on the earth are not representative of the universe as a whole. The perhaps not unique but certainly very exceptional conditions of temperature and pressure on the earth have favoured the synthesis of complex inorganic and yet more complex organic compounds, but these diverse forms of matter are not typical of the universe.

How is the chemistry of the stars studied? Obviously it must be learned from the only thing the star sends to us, namely, electromagnetic energy. The secrets of its nature are imprinted in the starlight. It thus becomes a question of spectroscopy — the analysis of the starlight and the decodifying of the message. Sir Isaac Newton laid the foundation stone when he investigated the prismatic refraction of light in 1672. Fraunhofer first carefully observed the many dark lines in the spectrum of sunlight, Kirchhoff first explained them. The cooler atoms in the outer atmosphere of sun or star are absorbing just those radiations which they would themselves emit if they were at a sufficiently high temperature to radiate, hence it is possible, by matching up absorption lines occurring in a stellar spectrum with well-known emission lines produced in a laboratory by raising known elements to incandescence, to identify the elements in the stellar atmosphere. This was done by Sir William Huggins, Sir Norman Lockyer, Father Secchi, and other pioneer astrophysicists.

Stellar spectra are now photographed at most of the leading observatories. Either the starlight passes first through the telescope and then through the prisms to the photographic plate (see Figs. 1 and 2), or else the prism is placed in front of the objective glass of

the telescope, and then the light passing on through the telescope falls on the photographic plate. In the former case one star at a time is photographed, in the latter arrangement all the stars in the field of view impress their spectra on the plate simultaneously.

Careful study of stellar spectra shows that there are many different types, but that they grade imperceptibly one type into the next. They were classified at Harvard Observatory in a sequence of increasing complexity of appearance, but subsequently it was realized that an order was possible which represented the changes resulting from gradually decreasing temperature. The main portion of this sequence is shown in Fig. 4.

Of the ninety-two elements recognized by modern atomic physics only two remain unidentified by chemical or by spectroscopic analysis of terrestrial matter. The elements not as yet detected in the stellar spectra are sixteen in number, namely: boron, fluorine, neon, phosphorus, chlorine, argon, arsenic, selenium, bromine, krypton, antimony, tellurium, iodine, xenon, gold, and radon. In addition to these there is considerable uncertainty with regard to some of the elements known as the rare earths and the following other elements: beryllium, germanium, indium, tantalum, tungsten, osmium, iridium, platinum, mercury, thallium, bismuth, thorium, uranium.

It should be remembered, however, that because the lines typical of these elements are not definitely identified in the stellar spectra, we need not draw the conclusion that these elements are absent. Various factors might enter into the question—the conditions required to excite the radiations or absorptions might not be exactly those of the stellar atmospheres, or the typical lines might fall in a region of the spectrum not obtainable, that is, too far in the infra-red or too far in the ultra-violet to be photographed. The amazing thing is not that so many elements are unidentified, but that so many are known beyond any shadow of doubt to be present in the stars.

FIG. 2.

THE BRUCE SPECTROGRAPH AT YERKES.

The spectrograph is attached to the lower end of the great Yerkes telescope. The light from the star, focussed by the telescope on the slit of the spectrograph, is made to pass through one, two or three prisms before falling on the photographic plate. To ensure steady conditions the spectrograph is enclosed in the constant temperature case seen at the right of the photograph.

From a Yerkes Observatory photograph.

The spectra of the hottest stars reveal the presence of hydrogen and helium and many ionized atoms of various elements, that is, atoms with an excess positive charge owing to the fact that not all the required electrons have been captured by the nuclei. An atom lacking one electron is said to be once ionized, if two are missing it is doubly or twice ionized and so on. In these hottest stars are ionized oxygen, nitrogen, carbon, silicon, calcium, magnesium, and the first four of these also appear in the twice ionized state.

As we pass to somewhat cooler stars some of the ionized lines fade out while others appear and also many lines due to neutral atoms—iron, titanium, strontium, barium, vanadium, aluminium, etc. It is at this stage, in the Class A stars, that molecular structure first puts its impress on the spectra. A molecule radiating or absorbing light does not do so as distinct lines but as one or more bands. Thus a whole region of the spectrum will be affected if molecules are absorbing light in the star's atmosphere, and a dark patch or band is produced, usually sharply defined at one extremity and gradually fading off at the other. This is best seen in the K and M stars in Fig. 4. In the A stars band structure is first seen and is due to the carbon nitrogen compound cyanogen.

A striking feature of a yet cooler spectrum, the solar type of Class G, is a narrow band at wave-length λ 4314, known as Fraunhofer's G-band, identified by Newall, Baxandall, and Butler with some hydrocarbon molecule. Stars cooler than type G whose spectra are chiefly distinguished by the bands of cyanogen, carbon monoxide, and hydrocarbon, are classified R and N according to the development of these bands.

The majority of the stars cooler than Class G stars, however, are not of Classes R and N, but belong to what is known as the *main sequence* which terminates with Classes K and M. Their spectra are free from the bands of carbon compounds, but in the M stars

the bands of titanium oxide are the dominant characteristic. No star is known whose spectrum shows both carbon compounds and titanium compounds, these two seem to be mutually exclusive. A small class of the cooler stars, very analogous to the M stars, are designated as Class S. Zirconium oxide bands are present in their spectra. Occasionally, but not always, titanium oxide is also present, but the zirconium oxide molecule appears to persist to higher temperatures than the former molecule can stand. Fig. 3 illustrates the sequence of stellar types above mentioned, though one cannot attempt to read into the diagram a simple evolutionary scheme. The whole question of stellar evolution is at present under reconsideration. New facts have altered old ideas. Theories which seemed tenable two or three years ago are either abandoned or regarded with cautious suspicion.

FIG. 3.

MAIN SEQUENCE OF STELLAR SPECTRA AND BRANCHES.

This diagram illustrates the sequence of stellar types, as exemplified by their spectra, though one cannot attempt to read into it a simple evolutionary scheme.

The spectrum of sunspots presents an interesting field of study, for their conditions are not typical of the undisturbed solar surface. Vast vortices of rising gas suddenly reach a level of lower pressure in the higher portion of the sun's atmosphere and, rapidly expanding, the gases cool down producing absorption spectra more nearly resembling that of stars of Class K. Sunspot spectra reveal the presence of water vapour and magnesium and calcium hydride. Bands of ozone and water vapour do appear in the spectra of stars but can be shown to be of telluric origin, that is to say, to be effects produced in the spectrum as a result of the passage of the light through the earth's atmosphere. If these bands were strengthened in the spectra of sunspots and the cooler stars, this would be evidence of the presence of these compounds at the source. This is so with the water vapour but not with the ozone. Theoretically ozone might be expected in the atmospheres of M stars, for Fowler and Strutt calculated its maximum thermal formation to be at a temperature of 3,500° centigrade at a pressure 10^{-7} atmospheres, conditions probably existing in the outer portions of the M stars.

In the ultra-violet spectrum of sunlight the bands due to ammonia have been identified by Fowler and Gregory.

The spectra of the planets are, of course, due to reflected sunlight, but they show certain absorption bands not present in direct sunlight and therefore due to the planetary atmospheres. In the case of Venus and Mars the effect is almost negligible, but Jupiter, Saturn, Uranus and Neptune certainly have atmospheres differing somewhat from that surrounding the earth. Unfortunately the bands in their spectra are of unknown origin as yet. Chlorophyll may be responsible for some of the bands, but the evidence is inconclusive.

The spectra of comets exhibit many features of interest. There are several bands as yet unidentified, while other conspicuous bands are due to carbon monoxide, cyanogen, and the hydrocarbons, possibly acetylene and methylene. The elements responsible for the line spectra are hydrogen, helium, sodium, and iron. Meteors are generally supposed to be typical of the material composing the head of a comet. This seemed definitely proved in the case of Biela's Comet, which returned once or twice showing signs of disruption and then was seen no more, but in its place at the appointed time there came a meteoric shower of considerable brilliance. The analysis of meteorites is therefore of significance—iron, nickel, calcium, silicon, gallium and rubidium.

In the nebulae, the spectroscopist has found hydrogen, helium, carbon, nitrogen, and several strong broad lines usually referred to as "nebulium" lines. Many speculations have been made regarding these. In the autumn of 1927, Dr. Bowen of California calculated how much energy would be emitted by certain unusual electron movements in atoms of ionized or doubly ionized nitrogen and oxygen, and found very good agreement with many of the nebulium lines. In support of this explanation of the nebulium lines Professor A. Fowler added further evidence, but the question remained:—If oxygen and nitrogen produce these lines, why do we not also find in the spectrum the lines most frequently associated with these ions?

An answer to this was given by Professor Eddington in December last. He drew attention to the change in the relative intensities of probable and improbable emission lines when the stimulating radiation is exceedingly weak, and the density of the gases of the nebula so low that once an atom has become ionized it will wander far and wide before encountering a free

electron which it can capture to complete its full quota. The picture we form, therefore, of a gaseous nebula is this: a vast expanse of space (so vast, indeed, that our whole solar system would be but an insignificant portion), filled with about as much gas—hydrogen, helium, oxygen, nitrogen, carbon compounds and so forth—as would altogether make up a mass equivalent to our sun. This tenuous gas is not at a very high temperature, but is being traversed by the light from nearby stars. Much of this light is absorbed by these tenuous gases and then re-emitted in the manner distinctive of the nebular conditions.

The chief debt of the astrophysicist to the chemist is in the development of ionization theory. The physical chemist has elaborated the theory of dissociative equilibrium. Saha, a distinguished Indian astrophysicist, realized that there was a logical analogy between this problem and the problem of ionization in a star's atmosphere. We know that electron bombardment upon a gas, or the passage of X-rays or other penetrating radiation, will disrupt some of the atoms of the gas, thus producing ionization. But ionization can come about in the absence of these agents. This *natural ionization* occurs spontaneously, the energy needed to expel the electron from the atom being drawn from the environment, which thus becomes cooler. This has proved to be a very fruitful line of investigation, but space will not permit of its discussion in this article.

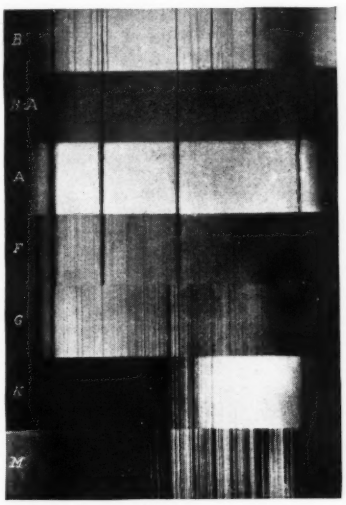


FIG. 4.
TYPICAL STELLAR SPECTRA.
Well-known stars whose spectra exhibit these typical features are the following: Early B—ε Orionis (Alnilam); Later B—β Orionis (Rigel); A—α Canis Majoris (Sirius); F—α Canis Minoris (Procyon); G—α Aurigae (Capella); K—α Bootis (Arcturus); M—α Orionis (Betelgeuse).
Photograph by Harvard College Observatory

Chemists, for the most part, think in terms of molecules. Biochemists, in particular, are wont to think of some very large molecules. Haemoglobin, for example, the red corpuscle in the blood, is a molecule of sufficient size and complexity to appal the average mind, for it is said to comprise about 100 carbon atoms, 200 hydrogen atoms, as well as many atoms of iron and other elements. Let not the chemist, however, boast of his giant molecules, for if it came to a contest as to who could think of the largest molecule, it would not be the chemist who would carry off the palm of victory. The astrophysicist would stand easily first.

There is a class of stars, of which the companion of Sirius is the best known example, called the white dwarfs. Hidden from view beneath the atmosphere of such a star, so much matter is packed so closely together that its density is about 50,000 gms. per c.c., or, in other words, one ton of matter is packed into every cubic inch of space inside the star. Observation and calculation point to this tremendous density and spectroscopic results confirm it, but can one explain it?

The explanation took this form. When we think of the compression of any substance, we picture the limiting density as being attained when the atoms or molecules have been pressed shoulder to shoulder, as it were. Greater density is only possible if each atom can itself be reduced in size. Now the effective volume of an atom is determined by the radius of the orbit around which whirls its outermost electron. The volume of the atom cannot be greatly reduced by compelling the electrons to move in nearer and nearer to the nucleus, but the volume can be reduced, and reduced many thousand-fold by removing the electrons altogether, that is to say, by completely ionizing the atoms. Our substance is then reduced to a gas made up of myriad electrons each having a diameter of only 0.000000000001 cm. and each moving with incredible rapidity unconstrained to any orbit, and of the atomic nuclei which, though they be over a thousand times more massive than the electrons, are a thousand times smaller in diameter. Such a gas may be compressed to densities far exceeding that above mentioned. This is apparently what has happened in these white dwarf stars, and in order to maintain their complete or almost complete ionization it is calculated that the temperature within the star must be almost incredibly high—of the order of 100,000,000° centigrade.

Just here a grave difficulty arose. The old physics teaches that the higher the temperature of a mass of matter the more intense will be the outflow of radiant energy from it. Thus our hot dense star, which to grow denser must grow hotter at its centre, ought to be radiating more and more fiercely as it grows older. But its total energy is finite, and hence the apparent contradiction that the time will come when its store of energy is almost exhausted, it will want to cool down but will not have retained sufficient energy to expand or lift its outer layers against gravity.

Such a perplexing situation can never arise in the natural world—it must be our physics that has led us astray.

We of this generation have seen the birth of the new physics, and though few as yet have grasped its full significance and mastered its principles, all may gain some idea of its line of thought and gaze with wonder and admiration at what the new methods have already achieved.

The new methods of physics have been applied by Mr. R. H. Fowler of Cambridge to this problem, with results which may be stated somewhat thus :—There are two definitions of temperature. One states that the faster the motions of the atoms or molecules, the higher is the temperature, and *vice versa ;* in other words, temperature is a measure of the average speed of the particles. The other definition states that temperature is a measure of the ability of a body to radiate. Under terrestrial conditions these two definitions agree perfectly and the old physics regarded them as synonymous ; but the new physics show that we cannot generalize and deduce that under all extreme conditions these two definitions will agree. Indeed, they begin to diverge very greatly when very dense matter is being considered. In our dense star the velocities of the free electrons and atomic nuclei are approaching the highest velocity possible, and hence one definition says that this is the hottest matter in the universe. But this very density means that any one particle has no choice as to where it will go next. There is possible but one place and one speed for each particle at any instant. Radiation depends upon there being freedom of motion, choice of next position for any particle, and hence where all such freedom is denied there can be no radiation. Hence by the second definition such a star is approaching the absolute zero and is therefore the coldest matter in the universe. Furthermore, matter in this condition has become strictly analogous to a molecule containing no excess energy which it can radiate away, and so the ultimate state of a white dwarf star is that it will be one great molecule.

Here the story ends, but we cannot do otherwise than demand a sequel. Such a final deadlock as above described is not in accordance with the trend of thought initiated by Galileo and deepened by the investigations of every succeeding natural philosopher into belief in

" . . . the perpetual round of strange,
Mysterious change."

If the old physics cannot solve the problem, and the new physics can go thus far and no farther, then we must wait hopefully for a yet newer natural philosophy to carry the final chapter on the chemistry of the stars beyond the *status quo* of the star molecule.

A Seashore Curiosity.

ALTHOUGH limpets, clinging tenaciously to the rocks like small pyramids of shell, are by no means an uncommon sight at the seashore, few people realize that the limpet is not quite so stolid and stationary in its habits as it would at first appear to be. Not only is it addicted to roaming about in search of food, returning usually to a fixed spot, but on certain parts of our coast, where it is in danger of being crushed by the large boulders churned up by the sea, it actually burrows into the rocks for safety. How long a limpet takes to make a burrow for itself, if any burrow can be taken to be the work of one solitary limpet, is a matter of conjecture ; but where the rock is of sandstone, it is no uncommon thing to find limpets embedded to a depth of quite half an inch, as the accompanying photographs show.

LIMPETS ON THE ROCKS AND (RIGHT) EMBEDDED IN SOFT SANDSTONE.

Athos : The Monuments of a Millennium.

By Robert Byron.

With special privileges for viewing its treasures, the author lately visited Athos, the Holy Mountain where for a thousand years the monks of the Greek Church have carried on their unique community. Fact and fable Mr. Byron elucidates at first hand.

THE Holy Mountain offers something of a challenge to the ordinary traveller. Access, provided its whereabouts on the map are familiar, is easy enough. The intending visitor must first reach Salonika, or, if he is coming from the east, Cavalla or Dedeagatch; and then, if he waits a day or two, a small steamer will eventually transport him in the space of twelve hours to the northernmost of the three fingers of the Chalcidice peninsular. Facing south-west, upon the inner shore of this woody ridge that winds like a forty-mile serpent through the silvery blue of the northern Aegean, lies the port of Daphni, a bight rather than a harbour and presenting no anchorage in rough weather. Great forested ramparts tower into the sky above the cluster of miniature buildings, a shop, two inns, and a warehouse like a cowshed, which denote the Liverpool of the Republic. And above them over to the right, risen 6,500 feet from the sea, rears the giant white cone in which the promontory ends.

Classic Renown.

It was the shadow of this, stretching seventy miles over the sea at sunset and dawn to the bewilderment of suddenly darkened islands, that brought renown to the Mountain in the pages of the classic writers. Then Christians annexed it, and added a more sophisticated lustre than natural phenomena alone could confer. This has remained, and, moreover, continues to shine with an intrinsic life which owes nothing to the feverish interference of antiquarians or artificial preservation societies. The traveller may focus on the past. But let him not forget that just as the Mountain fulfilled a need for the Byzantines, so it does also for the world of the Orthodox Church to-day. Temperamentally, East and West Europe are as far divorced as the cat from the dog. And there was a time, in the Middle Ages, when the civilization of the East was immeasurably the superior.

Meanwhile the ship is in, a gangway lowered, and a diminutive rowing boat bobbing up and down at its foot. On my first visit, I was in the position of the ordinary traveller; for I spoke no Greek, I was entirely ignorant of the elaborate manners and customs of the place, and the friend who was to act as cicerone had preceded me, and was waiting in the capital on the other side of the ridge. I recall still the waft of helpless apprehension that overcame me as I struggled with my bag down the stairs, and ultimately loosed my hold on the rational world of which the steamer was emblem. Slowly we rowed ashore; inexorably the steamer receded. Then all was bustle, for we must present our credentials to the government as soon as might be. The ride on mule-back to the top of the ridge, 2,000 feet up, lasted two hours. From there, a horizon of sea, risen halfway up the sky, appeared through the trees; and immediately below, set amid gardens and orchards, lay Caryes, the village-capital, where each of the twenty Ruling Monasteries keeps a representative to form the Parliament. Our friend met us, and he was a friend of that year's Protepistates, chief monk of the community and chairman of the Epistasia. To this body, an executive committee of four, we presented our letters of introduction from the Greek Foreign Office and the Metropolitan of Athens, and were furnished in return with a circular recommendation to the Ruling Monasteries, in the face of which none of them could refuse us hospitality. To accomplish all this, and then to claim that hospitality without the instrument of speech was almost impossible. The visitor must either have learnt Greek, possess a friend who has, or else assume the burden, both in expense and company, of a guide.

A Monastic Republic.

It doubtless arises in the mind of the reader that this talk of a monastic republic still flourishing on the sensible, utilitarian soil of Europe, is merely a technical fiction exploited by journalistic enterprise and invested with especial publicity value on account of its immemorial practice of excluding all females, both human and animal, from a luxuriant and ecstatically beautiful strip of the world's surface. In fact, this "female rule" is not the culminating monument to the fear of sex that is usually supposed. It was a simple means, conceived by Theodore of Studium, the monastic reformer of the ninth century, and borrowed by St. Athanasius of Athos a century later, of combating luxury; for without female

animals no meat or milk or eggs is produced; while the necessary beasts of burden have to be imported. Theodore's ordinance, it is true, was designed for a single monastery and St. Athanasius' after him. But in the eleventh century the trade in cattle evoked the complaint that Caryes was becoming a commercial town, and it was probably as a result of this that the rule was applied to the whole peninsular. This incident illustrates, moreover, the fundamental character of the Athonite community, which Western observers steadfastly refuse to recognize; namely, that in Eastern Christendom monasticism is not allied, as in Western, with learning and works of assistance, but is designed to promote, primarily, a mystical communion with the Universal God, and secondarily, an ideal social system. The monks to-day number five thousand; and in so large a community, scholars, workers of charity and rational thinkers are naturally to be found. But in essence everything is subordinated to contemplation and the elimination of competition. As aims, an obtuse and competitive world may term them selfish. But without necessarily affirming it, who shall deny that man's first duty is towards his inner peace? Modern civilization has chosen to identify that peace with "service." There are others, however, who disagree.

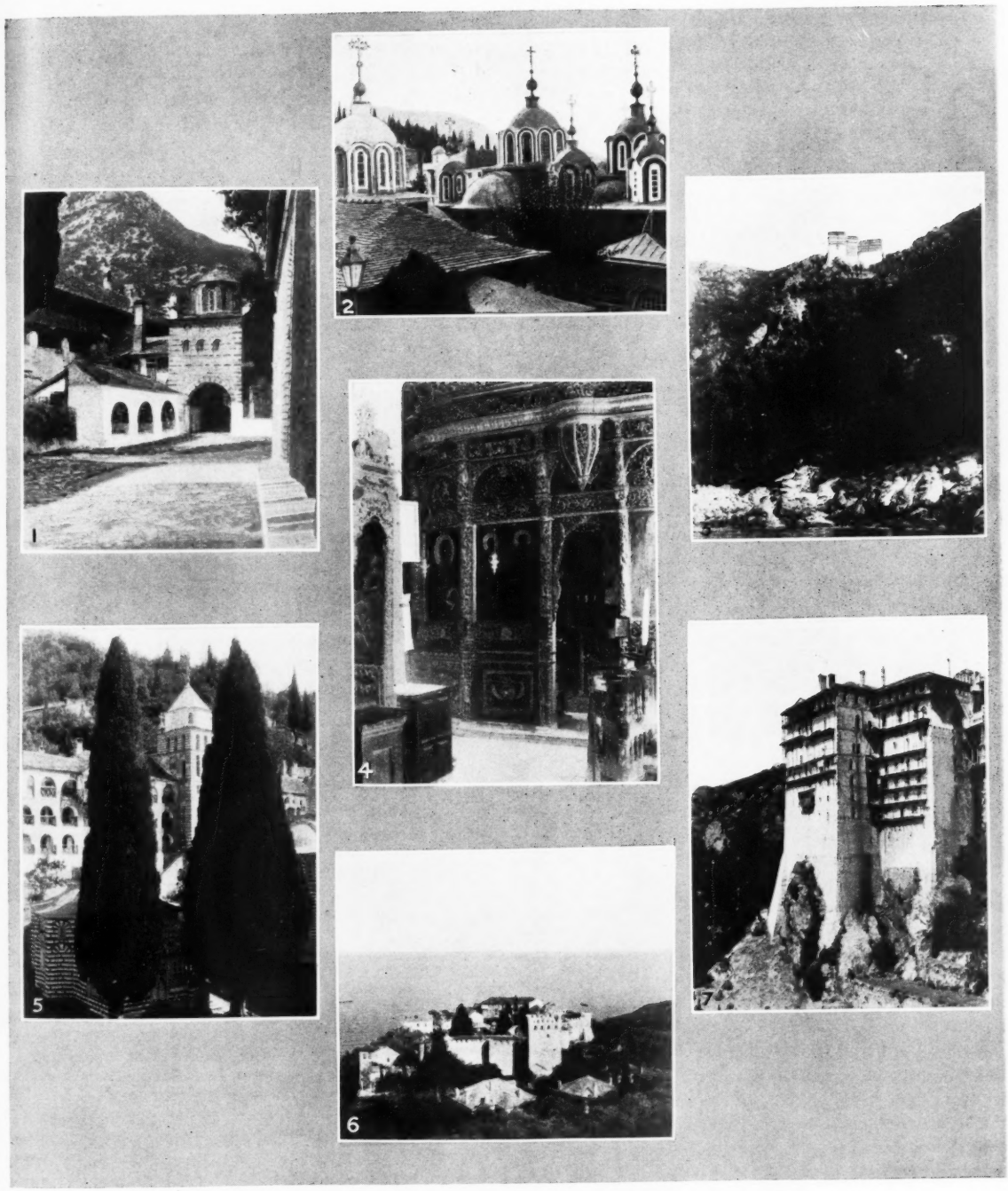
Early Hermits.

The Mountain was first invested with sanctity by hermits, of whom authentic records survive, and who were confirmed in their possession of it by a chrysobul from the Byzantine Emperor, Basil II Bulgaroctonos. This was in the ninth century; and it was in that century that Theodore of Studium, abbot of the monastery of St. John in Constantinople, sought to introduce a more coherent and communal form of living among the multitudinous solitaries of the Eastern Church. Imbued with the same ideal, Athanasius, a friend of the famous general and future Emperor Nicephorus Phocas, sought to found a regular monastery on the Mountain. Supported by his imperial patron both financially and morally—for the project did not lack opposition from the hermits, whose capital and framework of government were already situate at Caryes—he achieved his aim in A.D. 963. His foundation was known simply as the Lavra, in other words, the monastery; and there he lived till about the year 1000, when he was killed while helping to repair the dome of the church. His tomb may still be seen, together with an enormous cypress whose girth gives credence to the legend that he planted it. There survived also, till the beginning of the nineteenth century, the cell and library above the vestibule of the church, where he worked. These were then demolished owing to their precarious condition. But a picture of them, delineated in some detail on one of its piers, is extant in the model of the church that the Emperor Nicephorus is depicted holding in his hands after the manner of mediaeval benefactors.

"The Ruling Monastery."

Gradually, as the ensuing centuries progressed, other monasteries came into being on the Mountain through the generosity of the princes and prelates of the whole Orthodox Church. To these the scattered hermits were gradually, and at length definitely, subordinated, by order from Constantinople. Hence the expression "Ruling Monastery." For though there still exist many groups of monks living in separate cells perched about the precipitous cliffs, and even smaller communities dwelling in a common building, all the land and leases of the peninsular are the inalienable property of the twenty chief monasteries. The significance and value of this rule were only apparent in the nineteenth century.

In 1204 the Latin Chivalry of the Cross, led by Henry Dandolo, Doge of Venice, and Boniface of Montferrat, captured and sacked Constantinople. For sixty years the ancient Empire was parcelled out among upstart feudatories, and Athos, falling within the limits of the "Kingdom of Salonica," found herself under the plundering jurisdiction of a papal legate. The legends that survive of this period have grown rather than diminished in recent years. Thus, at the Bulgarian monastery of Zographou, the last century saw the erection of a stone cenotaph, in remembrance of the "twenty-six martyrs burnt by the Pope of Rome"; which was followed by a series of lurid frescoes depicting the pontiff's arrival in person to attend the immolation of the prisoners incarcerated in a tower. In reality these stories probably had their origin in the persecutions of the Emperor Michael I Palaeologus, who recaptured Constantinople and foresaw, two centuries before its actual fall, that only with assistance from the West could the Byzantines hope to retain it against the Turk. The price of that assistance was union with Rome. Hence the succession of futile concordats that now followed, resulting in minor coercions of the refractory, and culminating in the famous Council of Florence in 1438, where the attendance of the Emperor John V Palaeologus was immortalized by the brush of Benozzo Gozzoli, and the representatives of the Holy Mountain cast their weight against the union, conservative to the last.



THE MONUMENTS OF A MILLENNIUM.

(1) The courtyard of the Lavra monastery, founded in A.D. 963, showing the tombs of three patriarchs of Constantinople. (2) The domes of the church in the Russian monastery dating from the middle of the last century. (3) Simopetra, the "Rock of Simon," situated on the mountain side a thousand feet above sea level. (4) Church interior of the Bulgarian monastery of Zographou. (5) Two great cypresses at Zographou, older and taller than the buildings at their feet. (6) The Lavra, showing more cypresses. (7) Another view of Simopetra.

UNIV. OF MICH.

It was, as a matter of fact, surprising that they should have been there at all, since the Mountain had already surrendered to the Turks in 1430, upon their capture of Salonica. This voluntary submission was to prove an important factor in the preservation of the community's independence. The Spaniard, Pero Tafur, who was travelling in the East about that time, reports that the grandfather of Mahommed the Conqueror had already attempted to capture the Mountain, but that the plague had fallen on his host as a result and that he had been obliged to repair all the damage that he had done, and even to increase the monastic endowments. It was perhaps the outcome of this event which ultimately enabled the Mountain to surrender on its own terms of administrative autonomy. To those terms the Turks faithfully adhered during the four hundred and eighty-two years of their rule. And thus it happened that while the Christian governments of Western Europe were denuding the monks of the last semblance of temporal power, in the East their position was maintained by the more sympathetic comprehension of the infidel.

With the fall of Constantinople in 1453 Byzantine history is at an end. For three centuries, beyond the account of an occasional traveller, there is little to tell of Athos. The government functioned, nominally supervised by a Turkish deputy-governor who was obliged to respect the famous edict and leave his wives behind. Old customs were maintained; new ones evolved. But gradually in the eighteenth century, when the Turkish decline after the last of the Kiuprili Viziers set in, it seemed that the Greeks must one day regain their lost empire. Wealth, learning, and industry were theirs. And their advancing prosperity was reflected on the Holy Mountain in the attempt to transform it into a place of learning, by the foundation of a school, above the monastery of Vatopedi, known as the Athonias. But the monks resented this lay encroachment, this attempt to provide them with a material *raison d'etre*. The headmaster was driven from the Mountain by calumnies, and the building was finally gutted by fire. To-day it remains, a pierced shell, monument to good intentions and warning against them. Then at length, outcome of the rise in the fortunes of the Greeks, came the Greek revolution, in which the hotter-headed of the monks implicated the Mountain and thereby subjected it to such ruinous penalties that only one thousand members of the community remained. But the fortunes of the monasteries rapidly revived. And the many fine buildings of the nineteenth century, from the church of St. Paul's dating from the 'twenties, to the astounding monastery of Simopetra which was not completed in its present form till 1894, bear witness not only to the material prosperity of Athos, but also to the continued vitality of Byzantine aesthetics.

Still the Mountain remained within the Ottoman dominions, and one last menace threatened its violation as the sanctuary of a vanished civilization. In the latter half of the nineteenth century, the Russians, by pouring novices and money into the community, made a determined attempt to obtain control of this independent political organism in the Aegean. They were frustrated in their efforts by the inalienability of monastic property referred to above, but their aggression had one important result. The autonomy of the Mountain was for the first time recognized in international treaty. Finally, after the Great War, by a clause in the Treaty of Sèvres, afterwards ratified at Lausanne, Greece bound herself to recognize the rights, valid through centuries of the foreign monasteries only. With regard to monks of her own nationality, their position was made impregnable by a guarantee included in the constitution of the state. In return, the monks deposited the code of laws and government of their own framing with the Greek Foreign Office; and voluntarily admitted Greek sovereignty on what the English, in common parlance, term a "dominion basis."

Correspondence.

IS THERE A SURPLUS MALE BIRD POPULATION?

To the Editor of DISCOVERY.

SIR,—Whatever else of value it may lead to, the letter from Mr. Philips Price in *Discovery* will have done good in emphasizing that ornithology must concentrate on the larger problems of population, rather than on those of the bird itself. One great difficulty in the interpretation of such facts as have been recorded by Mr. E. M. Nicholson, in your columns and in his books, on the examination of such statements as are put forward by Mr. Philips Price, arises from the physical inability of the few isolated investigators to cover more than a small portion of the whole field of avian phenomena. That in the future many workers in this interesting and promising field of endeavour will discard the Victorian method of bird study in favour of the new lines of research indicated by Mr. Nicholson cannot be doubted, and your help, Sir, in permitting so much of your valuable space to be devoted to the subject, must be greatly appreciated.

The suggested surplus of males in general is to me a new phenomenon, but if substantiated would not be surprising; much old knowledge is having to be revised in the light of the new ornithology. Latter-day observations, although far from complete, show that the problems of bird population are wide-ranging in their practical significance, and from whatever angle they are approached they seem to open up new avenues of investigation.

Yours, etc.,

Thurston Villa, Elmdale Road, Palmers Green, N. HERBERT H. WARDLE.

A Sidelight on the Geography of the Past.

By F. J. North, D.Sc., F.G.S.

Department of Geology, National Museum of Wales.

Research continues to shed new light on the manner of deposition of coal, the most valuable of our economic geological deposits. The author describes the results of some investigations which reveal the distribution of land and sea during the accumulation of the coal measures in South Wales.

RECENT research into the distribution of a certain rare mineral in the coal-bearing strata of South Wales has proved, as so often happens, that a particular line of investigation throws light upon matters quite unrelated to the problem in hand. It was hoped to discover whether the mineral was more particularly associated with some coal seams than with others, but although the evidence proved inconclusive upon that score, it was found to have a bearing upon the wider problems relating to the geographical conditions at the time when the coal-bearing strata were being deposited.

Millerite was the mineral under investigation. This consists of sulphide of nickel, and crystallizes as slender needle-like crystals, brassy yellow in colour, and with a bright metallic lustre. In South Wales it occurs as radiating groups or tufts of crystals, together with other minerals, in cavities which are associated with cracks in the bun-shaped masses of ironstone that occur in the shales of the coal-bearing strata or Coal Measures (Fig. 1). The nodules (or concretions) of ironstone owe their origin to the local segregation within the Coal Measures (when they were accumulating as muddy swamp-deposits) of carbonate of iron and other compounds, and they owe their present characters to the fact that crystallization set up in what subsequently became the outer layers of the nodules. During the process of crystallization a substance decreases in volume, and in the case of the nodules of ironstone the result of the crystallization was that the material remaining inside the layer already crystallized was not sufficient, when *it* also had passed into the crystalline condition, to fill all the space available for it, and cracks were developed. These cracks were usually arranged according to a definite plan, some of them being concentric; those near the centre being arranged so as to divide the material into polygonal columns (see Fig. 1). Mineralized waters mingled in the space thus provided and, interacting, deposited their dissolved salts in the form of crystals lining the walls of the cracks, or even filled them. Among the most abundant of these minerals were calcite (carbonate of calcium, or carbonate of lime) and quartz, but associated with them in small quantities were the sulphides of certain metals such as nickel, lead, zinc, copper, and cobalt. Of these sulphides, the first was, on the whole, the most widespread, and the last the least abundant. It is with these two alone (the minerals *millerite*, sulphide of nickel, and *linnaeite*, sulphide of cobalt) that the remainder of this paper deals.

FIG. 1.
FROM THE SOUTH WALES COAL MEASURES.
Left.—A tuft of Millerite crystals from an ironstone nodule (natural size). Right.—Part of an ironstone concretion showing Millerite (one-fourth natural size).

After exhaustive inquiries, specimens of millerite were found to occur in fifteen localities in the South Wales Coalfield, at some of which linnaeite also occurred. Although the ironstone nodules that contained millerite were more abundant in association with some seams than with others, the records were not enough to justify the drawing of definite

conclusions upon the matter. Hence as far as its original object is concerned the investigation may be regarded as abortive. The question naturally arose: from whence came the nickel necessary to account for the presence of crystals of millerite in relative abundance (that is, for so rare a component of the earth's crust as a whole) distributed over a wide area in the eastern portion of the South Wales Coalfield? (Fig. 2). Since nickel and cobalt are almost invariably associated, the nickel (except in local ore masses) being the more abundant of the two, their origin in this connexion is undoubtedly intimately connected.

Information Wanted.

Unfortunately, very little is known concerning the distribution of nickel and cobalt as constituents of the earth's crust, beyond the fact that they occur in extremely small quantities in igneous rocks,* whilst they do not appear to be present at all in most sedimentary rocks.

The average of many analyses of igneous rocks shows that nickel is present to the extent of nearly 0.03 per cent; copper, lead, and zinc are present in very much smaller quantities. This is of interest in view of the much wider distribution of the ores of lead and copper than those of nickel, and is probably explained by the fact that the two first-named metals are more susceptible than nickel to the processes by which metallic compounds have been segregated in sufficient quantities to be exploited as ores.

The only igneous rocks in which nickel and cobalt occur in more than mere traces are those which are rich in iron-and-magnesium-bearing minerals, and which are poor in silica (such as the rock called *peridotite*, and *serpentine* which results from alteration). Such rocks are always associated with the deeper layers of the earth's crust, and, therefore, are only exposed at the surface in regions where there has been extensive denudation, as the wearing away of the earth's surface by atmospheric agents (such as rain, wind and frost) is called.

The reason for the occurrence of these rocks in the deeper layers of the earth's crust is that, during the early stages of its development, the superficial layers must have been in a molten condition. It is improbable that the same applies, as was formerly supposed, to the great bulk of the earth's interior, which from its density, its transmission of earthquake shocks, and from the suggestive evidence provided by meteorites, is believed to consist essentially of nickeliferous iron. When the superficial layers of stony material were molten, there was a tendency towards differentiation under the influence of gravity, the heavier material sinking and the lighter rising, so that the primitive crust of the earth may be thought of as consisting of concentric, but not sharply separated layers. The uppermost layers contained the lightest material—rocks rich in silica and corresponding in composition to the so-called "acid" igneous rocks, such as granite; whilst the lowest layers consisted of heavier material corresponding in composition to the more basic (that is, with less silica) igneous rocks. Between them were other layers of intermediate composition.

From their original deep-seated situation the peridotites and allied rocks would be more likely than any of the others to receive additions from the deep-seated metallic core, and thus come to contain traces of nickel and cobalt. Further, they would be less likely than the overlying material to penetrate the upper layers of the earth's crust, or to reach the surface during volcanic episodes, so that they would only be exposed as a result of the denudation of material that originally rested upon them.

These considerations were taken into account when attempting to explain the presence of the nickel and the cobalt in the sediments of the South Wales Coalfield, and it soon became apparent that although the investigation had for the moment failed in its original object, it was destined to throw light upon another problem altogether.

Land and Water.

It has long been realized that the study of rocks and their arrangement throws light upon the geographical conditions of the past; for example, if a bed of sandstone is found to pass in a certain direction into coarse pebbly rock (conglomerate), just as the sand along the sea coast often passes into a beach of pebbles, it is obvious what the pebble beds indicate. At the time of their formation, the place where they now occur must have been near the shore of the area of deposition, from which it is legitimate to assume that the original limits of the stratum have been reached, or are not far distant.

This indication of the way in which rocks yield evidence concerning their original extension, will illustrate the fact that when sufficient information is available it is possible to indicate approximately the distribution of land and water at the time of the accumulation of any particular group of rocks.

The evidence is very varied in its character, and sometimes comes from unexpected sources; for

* Igneous rocks are those which, like granite, were originally in a molten condition, and sedimentary rocks are those which, like sandstone, were laid down as sediments by a water action.

example, the distribution of millerite in South Wales throws light upon the geography of the later part of the carboniferous or coal-forming period.

In the British area the earlier geological periods were times of more or less continuous subsidence, because many thousands of feet of strata were deposited beneath the sea during the Cambrian, Ordovician, and Silurian periods. These rocks, which are extensively developed in Wales and the west of England, form the floor upon which rest the newer rocks of the midland and eastern counties. It is obvious that the accumulation in an ocean basin of a vast amount of sediment implies an equally vast denudation of the neighbouring land areas from which the sediment was derived.

The tendency of the natural processes that are shaping the surface of the land, by removing material and ultimately depositing it upon the sea floor, is gradually to level off the continental masses and to fill up the ocean basins. Therefore, if the denuding and depositing processes continue in any one region for a very long time without any appreciable changes of external conditions, the result would be to produce an extensive land area not much raised above sea level, passing into shallow mud-laden swamps.

This condition was reached in North-western Europe towards the end of the great marine episode of the Palaeozoic era. The peculiar feature of Coal Measure time was that after a long period of denudation and deposition, those two processes were more evenly

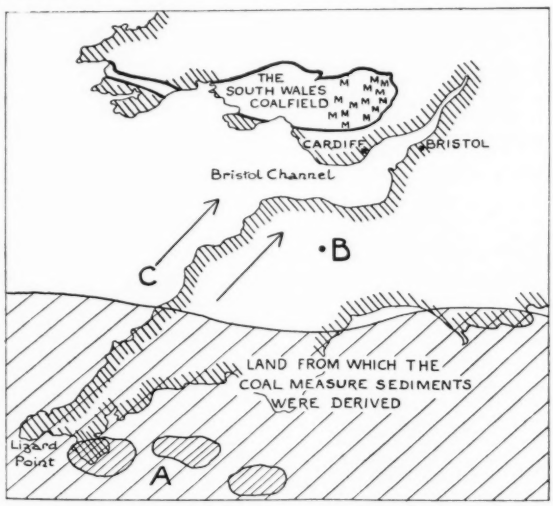


Fig. 2.

MAP OF THE COAL MEASURE PERIOD.

A.—Areas of igneous rocks (containing nickel and cobalt) exposed by prolonged denudation in late Carboniferous time. B.—Locality near Tiverton where nickel and cobalt occurs in the coal measures. C.—Locality from which material of coal measures was derived. M.—Localities where Millerite occurs in the coal measures.

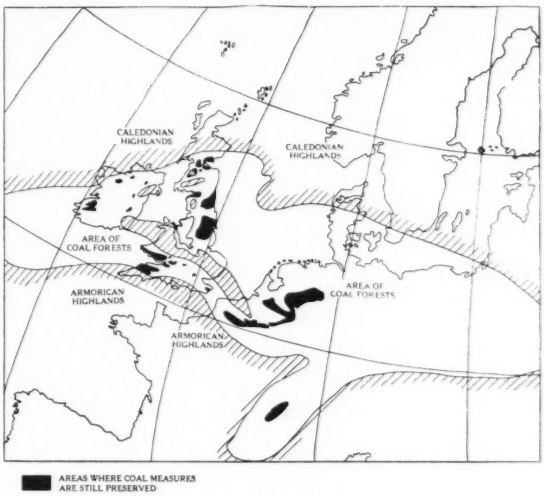


Fig. 3.

ORIGINAL EXTENT OF EUROPEAN COAL FORESTS.

Although deposited over a wide area the coal measures have escaped denudation only in the areas coloured black.

balanced than at any other time, with the result that the expanse of low-lying land near sea level and of shallow sediment-choked coastal waters, was unusually great, and the physiographical conditions were practically uniform over wide areas and for a long time. To this effect is due the wide extent of the coal seams of north-western Europe.

Such prolonged denudation must have resulted in the exposure, locally, of the lower layers of the earth's crust, and we may safely assume that during Coal Measure times, extensive areas of rocks that are usually deeply buried had been exposed, and were undergoing denudation.

At the present time, as we have seen, nickel and cobalt occur in association with certain kinds of igneous rock, or their altered products, that are found in regions where very old rocks have been exposed by the removal of the overlying strata. If an area of such rocks were undergoing denudation in Coal Measure times, and furnished some of the material for the South Wales Coal Measures, it is not unreasonable to look to that area as the source of the metals that gave rise to millerite and linnaeite. This suggestion is by no means without supporting evidence. Taken as a whole, the Coal Measures of South Wales tend to thicken in a south-westerly direction, and this, together with the evidence of current-action in some of the strata, suggests that the material was derived from the south-west. A similar conclusion was arrived at by Dr. A. Heard, as a result of an examination of the heavy minerals present in certain of the sandstones.

Now, in the Lizard district of Cornwall there is a mass of very ancient rocks, including several varieties of serpentine, all of which contain nickel and cobalt in association with iron ores. Although the area now occupied by these rocks is small, most of its margin is determined by the sea, and it may represent only part of a much larger mass, or one of numerous masses that may have existed in the land region, which, when the Coal Measures were accumulating, occupied the site of the South of England, the English Channel, and Brittany. It was on this land-mass that earth movements, towards the close of the Coal Forest period, resulted in the elevation of mountain ranges called by geologists the Armorican Highlands, after the Armorici, a tribe that once inhabited Brittany (see Fig. 3).

If, therefore, a land-mass to the south and south-west provided at least part, if not all, of the inorganic material of the South Wales Coal Measures, and if in that land-mass there were areas of nickel-bearing and cobalt-bearing rocks undergoing denudation (and it should be borne in mind that owing to the peculiar conditions of the time, to which reference has already been made, larger areas of such rocks may then have been exposed than are now to be seen), we have an explanation of the source of the nickel and the cobalt in the Coal Measures (Fig. 2). In this connexion it is interesting to record that the two metals have been found in association in rocks of similar age at Hockworthy, north-east of Tiverton, which lies between the region of the Armorican Highlands and the South Wales Coalfield. Thus, while the general character of the deposits indicates that during the coal-forming period land existed to the south of the British area, the presence of the mineral *millerite* in the ironstone nodules of the South Wales Coalfield throws light upon the nature of that land. It suggests a country in which mountain masses had been raised during periods of earth movement, and the surface of which had, by Coal Measure time, been so lowered by denudation that the mountains had been worn to mere stumps, and the old, once deeply buried rocks of their innermost cores exposed. Towards the close of Coal Measure times the earth movements were resumed, because high mountains were again raised on this ancient land.

Is there a Surplus Male Bird Population?

By E. M. Nicholson.

Author of "How Birds Live."

Recently a correspondent described new observations which led him, arising from Mr. Nicholson's book, to postulate a surplus male bird population. Mr. Nicholson was away at the time in the capacity of ornithologist with the Oxford Expedition to Greenland, and in reply he now suggests by what means observers might co-operate to discover an adequate answer to this question.

THE question whether the bird population contains a surplus of males, which was raised by Mr. Philips Price in the August issue of *Discovery*, certainly deserves more attention than it has so far had. Unlike many ornithological problems it seems capable of fairly rapid solution by straightforward methods of observation. The reason why so little is known about it is simply that so little has been looked for. Ornithologists have been concerned with matters which seemed to them more important, which I will resist the temptation to specify.

Unfortunately, the question of the surplus males cannot be disentangled from the general problem of organization during the breeding season. The best proof of this is Mr. Philips Price's letter, which, in spite of the care he has taken over stating his case, assumes throughout that a non-breeding population postulates a surplus of one sex—in his opinion the male. But there are three necessary conditions before breeding can take place; it requires the conjunction of an adult male, an adult female, and a suitable territory furnishing both food and a site for the nest. Theoretically, then, breeding might be frustrated in more than one way; the male, for instance, might secure a mate but not a territory. In practice it seems to be the rule (although exceptions undoubtedly occur) that the male must find his territory before he can think of mating, which explains why the male warblers on their way north in spring outstrip the females just when it seems most desirable that they should be together, and arriving in England a few days earlier hasten to seize a territory before turning their attention to a mate. Having these two conditions to satisfy they seem deliberately to put territory first and let the mate look after herself. This is curious because, while it would be simple enough for a pair to go house-hunting together, the single cock, once he has secured his territory, is tied down to it, and

unless a mate comes along of her own accord he is left in the lurch. And that does actually happen; wood-wrens and tree-pipits, for instance, will arrive and sing three weeks or so at the chosen spot, and if they fail to mate will abandon it at the eleventh hour in favour of some other quarters.

The Forlorn Female.

Now this system by which the male finds the territory and the female finds the male must obviously exact a good deal from the hens. Aided by the songs and conspicuous actions of the territorial cocks, they have to find eligible mates in a very short space over a great extent of country. To provide mates within three weeks or so for all the cock willow-wrens from Dover to Stornoway is a formidable proposition, and it would hardly be surprising if on a closer scrutiny the machinery of distribution turned out not to work perfectly, so that one region had a local surplus of cocks and another of hens. Therefore, before we jump to the conclusion that the cocks outnumber the hens, we must have very detailed and accurate information from a large number of representative localities. Quite possibly it may be found that some have a large population of mateless cocks, others of mateless hens, and others of non-breeding adults of either sex, who are either not sexually developed at the time or are excluded by shortage of territory. There is a further possibility, often realized in the Arctic, that a cock after securing both territory and a mate may be frustrated from breeding by unfavourable weather conditions, but this is really a case where the requirement of *suitable* territory has not been fulfilled so far as that season is concerned.

As the territorial system requires the cock to make himself conspicuous in every possible way, it is clear that anything leading to large numbers of both sexes remaining mateless would appear as a surplus of cocks; the single hens, though they might be more numerous, would remain in the background and ordinarily would be hard to discover. In fact, even the most careful census will not give a satisfactory figure for unmated hens, although it may indicate their existence, as some of my censuses have done. The readiness with which birds of either sex, and of comparatively rare species, replace a mate lost during the breeding season seems to indicate a large and mobile non-breeding population always ready to step into gaps, and the best, if not the only, way of getting evidence on this seems to be the non-humanitarian one of catching the hen or cock at selected nests and seeing how often the operation can be repeated. This might be done with starlings or great titmice, for example—to name two common and easily taken forms whose sexes are distinguishable in the hand—and the value of the data would certainly outweigh the inconvenience to the birds.

Should it prove possible, as is alleged, to catch hen after hen on the same nest and to repeat the process in various parts of the country, the theory of a surplus male population will begin to look untenable. If Mr. Philips Price is willing to try this experiment in Gloucestershire next spring, I will see what can be done about it at Oxford, and perhaps some other observers elsewhere may come forward to co-operate. The results ought to give some indication of the real state of affairs. If the kidnapped hen proves irreplaceable a case for the surplus male theory will have been made out, and kidnapping a series of cocks will put it further to the test. No doubt an interesting situation will arise when all the kidnapped mates are let out. Watson and Lashley, when they experimented with the homing ability of noddy and sooty terns on the Tortugas, discovered that a husband returning after a long odyssey was liable to find himself replaced, and to be hustled ignominiously off his former territory by a successor who did not know him from Adam.

Victims of Economics.

Without having much evidence to go on my present impression is that the non-breeding bird is generally a victim of economics rather than of an unequal sex ratio, although the fact that many cocks—white-throats, for instance—first secure a mate very late in the season seems to suggest that faulty distribution may cause local disparities between the sexes which may not be rectified in time. In Greenland last June with the Oxford Expedition I could find no non-breeding population among the small passerines, and the only indication of an unequal sex ratio among land birds was an occasional case of bigamy in the ptarmigan. I put this down to the fact that the severe winter and the perilous migration required to avoid it leaves a population out of all proportion to the immense summer food resources, so that there is territory for all comers. The more open and uniform nature of the country, and the fact that it forms such a narrow ribbon round an uninhabitable ice-cap, no doubt make perfect distribution easier. It appears to me that anything like a standing surplus of cocks must strike at the roots of the territorial system by making the hens instead of territory the main object of rivalry. In fact, it would tend to reduce all birds to the condition of the ruff, in which (as Edmund Selous has shown in his masterly "Realities of Bird Life") many cocks gather at one hill to compete for

the favour of the reeve, who chooses by her own will or caprice, over-riding all other considerations. I see no trace of any such power among the hens of normal territorial species, and therefore I believe that the hens cannot be numerically in such a favourable position as Mr. Philips Price seems to think. When he suggests that the frequent celibacy of his Gloucestershire nightingales may be due to their being on the fringe of the range, I am inclined to agree with him, although the nightingale does certainly breed in the Wye Valley and parts of South Wales.

It is recorded in the July number of *British Birds* that a similar bachelor nightingale has appeared and sung for a few days "almost every spring for the last five-and-twenty years," in the Aune (Avon) Valley in Devon, far west of the traditional limit of the range. But if we accept this explanation in the case of the nightingale, it clearly cannot apply to the chiffchaff and willow-wren, among which Mr. Philips Price suspects a similar state of affairs, for both these extend north into Scotland and west beyond the Irish Sea, and we still have to fall back on uneven distribution or inequality of the sexes. It would be interesting to learn what methods he has discovered of distinguishing the sexes of great skuas in the field—a thing which so far as I know no other ornithologist has hitherto succeeded in doing. While the evidence that the party met with were unmated birds seems fairly convincing, we have no evidence at all that they were males, which is the point at issue. The presence of unmated birds of either sex is, of course, a familiar feature, especially in the north, where summering turnstone, purple sand-pipers, and many duck have often raised false hopes of additions to the list of British breeding species. The red-necked phalarope, the other species which Mr. Philips Price has cited, is hardly a legitimate example; its breeding habits, with the females dominant, are scarcely less abnormal than the cuckoo's, and like that bird's are quite probably connected with a heavy surplus of males.

Scope for Observers.

But in criticizing some details of Mr. Philips Price's argument, I am not suggesting that his letter is not an interesting contribution, which may be valuable in drawing attention to a matter which, as he says, has so far received too little. There are scraps of evidence from many regions suggesting that his view may be at least partly right, although I do not share it myself. Thus Wetmore in South America during a recent breeding season noted "Flocks . . . composed mainly of males that were not breeding, some in a condition of partial moult of the body plumage" in the case of the crested tinamou; and on 8th November, 1920, between 5 a.m. and noon, he saw 15-20,000 pintails (*D. spinicauda*) of which over 95 per cent were males, which had either not bred or had deserted their mates and migrated during the breeding season. In this country many counts of duck have brought out a disproportion between the sexes, but as they either do not refer to the breeding season, or cannot take account of sitting females, they only indicate what is seen and cannot prove an actual disparity. There are, however, many common birds whose sexes are clearly distinguishable, which are admirably fitted for intensive study, and if a few observers would turn their attention to the subject there is no reason why it should remain in such an unsatisfactory state much longer.

Lecture Demonstrations.

A PRIVATE demonstration has been afforded to *Discovery* by Messrs. Sands Hunter of a new epidiascope, the "Zeiss-Ikon," which constitutes a marked improvement on previous models of projection apparatus. Three methods of projection are provided for, as in addition to its use for prints and other opaque objects, and lantern slides, there is a microscopic slide attachment. The arrangement is such that a print and a lantern slide may be placed in the instrument at the same time, and by merely turning a lever one or other can be shown on the screen at will. The advantage of this to school lecturers is obvious, for crystals, mechanical apparatus, or a small scale experiment can be shown at one instant, and the underlying principles illustrated a moment later by the projection of a lantern slide diagram. For convenience in demonstrating, provision is made for the insertion of a pointer into the body of the instrument, and thereby attention can be drawn to particular details.

While the lantern slide holder is built into the instrument, it is necessary to use an attachment for the microscope slides. This is inserted in place of the lantern slide lens, and a valuable detail in this connexion is the provision of a heat filter to prevent the possibility of damage to the slides from the heat of the lamp. The advantage of this attachment is, of course, that a considerably magnified image of the microscopic slide can be thrown on the screen and seen by the whole audience or class at once, thus saving the great amount of time which has to be spent if each member is to see the slide in the microscope.

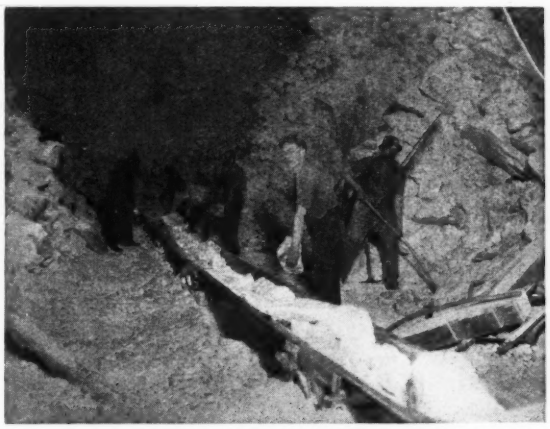
The shape of the epidiascope is not unlike a coal box placed on its side, and instead of the previous exterior ventilator, the top in the new model is neatly perforated like the radiator of a motor-car engine.

A Holiday in Search of Salt.

By Hugh Nicol, M.Sc.

Humorous adventures were met with in Austria during a fortnight's holiday which included the business of seeking a specimen of transparent rock-salt. The author travelled about 2,500 miles before he met with success, in following up a trail to which he had only a postcard clue.

NEEDING pure clear crystalline salt for a scientific purpose, and having found that the quality I required was not obtainable in sufficient quantity in Great Britain, I wrote to the propaganda department of the Austrian State Railways to ask them where in Austria I might hope to find what I needed. Nearly a fortnight passed, and the first day of my holiday had arrived without any answer, when I received a letter from Austria just before leaving by the night train. The Austrian railways, I learned, had been good enough to get into touch with the Austrian Salt Union, whose address was given as "Porzellang." Evidently I had to find "Porzellang," although I owned no more details of Austrian geography than I had been able to gather from the travel literature.



THE STASSFURT SALT MINES.
A mechanical conveyor is here seen loading with white salt. The absence of props or other roof supports may be noted.

I looked forward to the journey, feeling that a pleasant holiday awaited me even if I could not obtain what the famous Tyndall—who incidentally had help from influence and acquaintances to which I could not pretend—called categorically "this precious substance." The English Salt Union had already given me several pieces of their museum specimens, at the same time informing me that the British salt, in the form in which I required it, was not so suitable as that from the famous mines of Wieliczka in Poland. But Poland is distant; and had not Austrian salt contributed to the place-names of the country?—Salzburg, and the Salzkammergut, were suggestive. Hall and Bad Ischl were famous for their salt-mines, and I had noticed several places of which the names ended in *-ang*, but I could not find Porzellang; probably it was an industrial centre not worth mentioning in a tourists' booklet.

Innsbruck is only a few miles from Hall, and, having arrived at the western end of Austria, I felt that the quest had really begun. Changing some money at the station bureau, I asked for help in finding "Porzellang," showing the postcard. My German was not good enough to explain the place-name analogy which had misled me—but "Porzellang." meant *Porzellangasse* in Vienna! It is, of course, common to use *g* as a contraction for *Gasse* (street), and if any indication had been given that the address was Viennese, I should have had no difficulty in recognizing it; Vienna, however, had not been mentioned. Now, Vienna was some four hundred miles further on, and in some doubt as to what course to pursue, I decided to try my luck at some of the mines *en route*, starting with that at Hall, which is the largest in the country. This proved useless, for what I wanted was not the ordinary salt turned out by the thousand tons, but the clear variety called by the French *sel gemme*, and very scarce it is. Taking the train towards the Salzkammergut group of mines, which were for long in the jealous possession of the princely bishops of Salzburg, I next visited the mine at Dürrnberg, near Hallein, which has been worked since prehistoric times.

This mine lies entirely within a hill, and for that reason no vertical shafts are needed; access to the workings is obtained by nearly horizontal tunnels which open quite inconspicuously in the wooded mountain side. Some are lined with masonry, some are hewn in the rock, and some are heavily propped with timber. The main entrance is at the top, and after a gruelling climb, visitors are glad to take a rest while waiting for the guide; to both sexes overalls are given, and the donning of these fancy-dress costumes, which bear little resemblance to the dress of the actual workers, is not the least impressive part

of the visit. There is a leather apron worn behind and a leather grip for the right hand. The ladies have to be equipped for riding astride. The guides take acetylene lamps, and conduct the party to the back of the offices, where a narrow passage, looking exactly like a cellar entrance, leads into the recesses of the ancient mine.

For some distance we proceed in single file, queerly conscious of being underneath the marble church which was so conspicuous on the hillside we have just left, and then the guide shows us the first traces of salt in the unfruitful rock, traces so small that unaided we should never have found them. With quickened interest we walk on, to a branching of the ways, where menacing passages stretch into the unknown dark ; they are not our ways, and are not lit. A little further, and we see evidence of the need for care—ancient timbers crushed and splintered, and fragments of leather, half fossilized, are incorporated into the rock itself. Even more grim seems the narrow slit where hardly a cat might enter, which marks a tunnel wherein men once worked, now slowly but irrevocably closing under the swelling influence of atmospheric moisture that has been let into the interior of the mountain by the way we have come. In a wider space, where there is another level road, and a tunnel sloping steeply down into darkness, the guide halts, and waits for the tail of the file ; he stands at the head of the descending passage. Except for the shiny wooden beams on its sharply inclined floor, it might be one of those funnels by which Jules Vernes' travellers went into the depths of the volcano. Where do we go now? The other road is not lit : the guide sits down on the brink—we are to slide behind him into the depths !

A Dizzy Descent.

At the bottom we release our leather grip from the friendly brake-rope, which has not prevented us from attaining a dizzy speed, and stand up. Like everyone else who has been presented with this initially hair-raising experience, we ask if there are any more *Rollen* to come. We are grateful to hear that there are no fewer than five more, and we walk steadily on for a dull five minutes wondering when the next Rolle will announce itself ; some of our attention, however, is given to the specimens in the museum in the heart of the mountain, and to the lighted model scene of the legendary gnomes who used to dig for salt until they were frightened away for ever by the first stroke of the bell of the first church in Dürrnberg. We cross the frontier into Germany, and come back again—no tiresome *Passkontrolle* or customs here ! Then through a shaft we are given a peep at the lake a hundred and fifty feet below, and after two long glides we reach this Midland Sea, almost expecting to hear prehistoric beasts crashing through the (non-existent) undergrowth. However, we are ferried across in dead silence, and marvel at the vast underneath of the mountain unsupported above our heads. It is interesting to note that in these sunless regions the roof of the brine-lake caverns is called *Himmel* (sky) by the miners. Finally, we glide out astride a trolley again into daylight, to the absence of which we have become almost accustomed in the past hour.

The Quest Fulfilled.

Beforehand, while waiting for a party to assemble, I had got into conversation with Herr Ressel, who showed great interest and held out hope of a suitable piece of salt being obtainable later, if I would come back after going down the mine. Whether this was a test of sincerity of purpose I know not, but I made that climb again ; my friend was not there, and I was on the way down for the last time when somebody came running after me with a piece of clear rock-salt—the only piece of salt I obtained from Austria. At this point I may record that upon my return to England I found a very friendly letter from the Austrian Salt Union, offering every facility, but saying that—like the English Union—they could only refer me to Wieliczka, as no clear salt was to be found in present-day Austria. Here, then, was an interesting example of persistence of error, long after political boundaries had altered. Though I am not sure of the exact pre-war delimitations, I know now that clear rock-salt is scarcer in Austria than it is in Cheshire.

My next visit was to the mine at Berchtesgaden, across the German frontier. Berchtesgaden is a lovely spot, insufficiently known by British holiday-makers. The mine possesses a large, irregularly-shaped cavern about sixty feet high, formed by the removal of impure salt ; the walls are entirely composed of grey salt. It should be realized that this cavern is not a spectacle of dazzling whiteness, nor does it resemble the elaborately-sculptured halls of Wieliczka. A few show-pieces of simple design, worked in crude salt, are the only ornaments of the rock-like chamber, from which descends the only long *Rolle* that the mine contains. This one, however, is more dizzy than those of Dürrnberg and there is no brake. It took me an appreciable time to collect my thoughts at the bottom ! The mine has the unexpected luxury of a comfortable electric lift, for visitors only ; by this

detail, with fanciful illumination and the apparent absence of workers or signs of work, one is led to think that the visitors' "traffic" is the mainstay of the mine. Nevertheless, work unseen is proceeding insidiously, brine passing out by a couple of small pipes which seem ridiculously inadequate to represent the product of hundreds of years of excavation of miles of passages—for long distances through hard rock—or to feed the huge evaporating works in the distant valleys below.

When I inquired at the Berchtesgaden mine office there was not a single piece of clear salt of any kind, but an official recommended me to go either to the famous potash mines at Stassfurt, or else to an address which he wrote down as Hildesia Mine, near Magdeburg, some five hundred miles away. It looked, as the Americans say, "a proposition," since if Magdeburg drew blank, I should be near Stassfurt. I arrived in Magdeburg in the small hours, and was obliged to spend the rest of the night in a wretched hotel such as I should not have thought Germany possessed; its unappetizing breakfast was all I had to eat till late in the evening of an exhausting and unsatisfactory day, lightened only by the truly extraordinary kindness of a local policeman. Herr Mallnitz found time to take me to the offices of a Magdeburg newspaper in a painstaking but unsuccessful effort to trace the vague address brought from Berchtesgaden.

THE AUTHOR'S QUEST.

Part of a page of *Discovery* photographed through a piece of unpolished Stassfurt rock-salt, an inch and a half thick, through which the print can be clearly read. Difficulties of refraction prevent the whole from being in focus at once.

THE "ROLLE" AT DÜRRNBERG.

Entrance to the Durrnberg salt mine is made by polished wooden beams—the *Rolle*—on which visitors, dressed in special white overclothes, slide into the depths. The hand rope provides the only brake.

Proceeding to Stassfurt as a last hope, knowing nobody in the town, I walked about ten miles in an effort to find the offices of the mines. I passed the offices without knowing it, and when I had discovered the mistake, it was too late to do anything more that night. Next morning I was received with great kindness at the offices of one of the mine groups by Herr Knöppler, who sent a man into the mine with special instructions to look for the salt I required. He also gave me a letter of introduction to his friend Herr Reimann, who, he knew, had some picked specimens. I became indebted to both these gentlemen for pieces of great purity. Incidentally, they had no difficulty in finding the address of Hildesia, but it was in Hanover, two hundred miles away; it was reassuring to find that I had not been a victim of a hoax. I met with like efficiency, and readiness to please a stranger, in the Anhalt mines on the other side of Stassfurt. Upon the fields adjoining the factories abundant crops were raised; they extended literally up to the walls of the factories, and all around, but with no sign of damage to vegetation from the fumes of the noxious processes carried on within. The earlier annoyances and strange contrasts made the day one of the queerest I have ever spent, but I had seen the perfect thoroughness of the German chemical industry.

Papers at the British Association Meeting.

(By Our Special Correspondent.)

A record attendance was obtained last month at Glasgow by the British Association. As the printed proceedings fill a substantial volume, our report is confined to a few outstanding papers, with some general impressions of the meeting.

EACH annual meeting of the British Association has its own distinctive characteristic; and to this rule the gathering at Glasgow from 5th to 12th September was no exception. Perhaps owing to the size of the town and the numbers of the population the British Association badge was less noticeable in the streets than on other occasions, while the distance of the University, where the meetings were held, from the centre of the city tended to confine the members to one area, with the advantage that they remained more closely in touch. In consequence, the sessions of the various sections were more fully and constantly attended than is sometimes the case. In recent years the numbers at the meetings have tended to increase—a hopeful sign of the rising interest in science. The Glasgow meeting was large, indeed well above the average, and passed the three thousand mark.

A meeting of the British Association has a twofold audience. It is addressed in the first place to the scientific world and general public at large; but its proceedings must also have in view local problems and local needs. Nor must it be forgotten that the visitors have an exceptional opportunity of learning from those who know at first hand the conditions, problems, and resources of the locality in which the meeting is held. That Glasgow and Scotland had much of interest to impart was to be gathered from the sectional programmes, particularly in Agriculture, Forestry, Education, Geography, and Anthropology.

Though it may appear invidious to select when so much was excellent, mention must be made of Sir George Macdonald's Presidential Address to the Anthropological Section on the Archaeology of Scotland, in which the interest of the subject matter was enhanced by consummate artistic delivery; Professor Bryce's stimulating discussion of Human Distributions in Scotland; and the skilfully grouped series of illuminating papers on the geographical factors at Glasgow.

The concentrated attention with which the audience followed the address of the President, Sir William Bragg, was perhaps no more than was due to the importance of the occasion and the interest of the subject, presented in a masterly manner. But it was a feature to be marked at the evening discourses and most of the meetings of the sections. Like the increase in the number of members, it may perhaps be taken as an index of the extent to which science is beginning to take a grip of a wider circle of the public as a live interest, and no longer regarded as a closed book to all but a few who are in but not of this world.

Science and Craftsmanship.

Sir William Bragg ably surveyed the relations of Science to Craftsmanship in its truest and broadest sense. His theme may be summed up in one of the original statements of the purposes of the Association, which he quoted: "To obtain more general attention for the objects of Science." His definition of craftsmanship was "the skill which is exercised in the production of whatever is wanted for human welfare." Craftsmanship has a value in itself, being the result of the natural desire of men to use what faculties they possess. In its widest sense it not only represents a nation's efforts to live—it is its very life. From the craftsmanship which gave the world the vase of Ancient Greece and the Roman arch has evolved the modern craftsmanship with its dependence on machinery and with its wealth of production.

This evolution is the result of the individual's wish to better his material condition and that of his neighbour. It could not have been prevented, and with all its noise and ugliness we must recognize the plain truth that modern craftsmanship supplies the necessities of life to millions who would otherwise die. The urgent drive of self-preservation has forced the craftsman, time and again, to call in science to his aid. Sometimes the call and reply has been prompt and effective, as when the dwindling coal industry was saved by the discovery of the steam engine; at other times the application of scientific knowledge has been slower, as in the case of the Clyde shipyards. In the latter case the growth of science and craftsmanship has been simultaneous, through the co-operation of laboratory and factory. For the greatest prosperity this must be so, as is

evidenced by the remarkable fact that the most active of our modern industries are those which have been founded on recent scientific research—especially the electrical engineering, dye, motor, rubber, and the chemical industries. Compared to these modern industries we have the spectacle of serious depression in the pre-eminent industrial trades of coal, steel, wool, and cotton.

According to Sir William Bragg there are two reasons for this depression. The first is that, although the means for improvement, the intelligence, skill, and other qualities of our craftsmen, are present to a remarkable degree, they are not made use of by the contact of scientific knowledge and industrial experience. The second is that mass production in any industry must be destroyed or replaced as well as built up by scientific research. A high value must be placed on the services of the new class of worker engaged in research associations and industrial research laboratories, for they are the men who can utilize to the full, because of their understanding of purposes and methods, the advantages of personal contact with both the factory worker and the directorate.

Only by a true understanding of "science" can craftsmanship grow into all that it should be and stand for, Sir William concluded; and craftsmen learn to be of greatest use to their fellowmen.

The Live-stock Industry.

For the first time since 1912 the development of the live-stock industry was discussed by the Agriculture Section. Statistics show that in almost every part of the Empire, except Canada, the live-stock industry, including its products such as butter, cheese, eggs, etc., accounts for by far the largest percentage of agricultural produce. The imperial importance of the industry is apparent when we consider the dependence of the home population on foreign meat supplies. In the future, however, severe competition may be expected from the Dominions.

From the statistics given it is shown that although during the last fifty-five years the area cultivated for cereals in the British Isles has fallen by about 4,000,000 acres, the number of live-stock has increased and the density of the stock population has been maintained against severe overseas competition. These statistics are compared to those from Denmark where, in the same period, there has been an almost complete change from arable to stock farming. This change has resulted in a vastly increased area of arable land, since arable farming supports more stock than grass farming.

Since there has been a steadily growing demand for small joints within recent years, the problems confronting the industry are those effecting the early maturity and quality of stock. Unless the breeding stock of Britain is improved and graded up to a high standard, the general stock will never mature quickly nor improve in quality. Early maturity has the economic advantages of quick turnover, economical conversion of food, and higher command of price. State aid for the purpose of live-stock improvement is a development as recent as 1885. During the last decade, however, Canada and Northern Ireland have introduced legislation, resulting in grants for the purchase and licensing of high standard bulls for breeding, with very beneficial results.

The disparity between the commercial cattle and those of our pedigree herds in these islands is very marked—considering that the latter have been utilized to improve the world's stock. The urgency of the problem drew the following two proposals from Dr. Gordon: the desirability of (1) the increased use of pedigree sires, and in this direction the State can with great advantage to itself provide a powerful stimulus by the rapid extension of the premium scheme; (2) the elimination of the scrub bull, which, in his opinion, with human nature as it is, will only be accomplished in an effective manner by legislative means.

These proposals were among others advanced that showed how alive modern agriculturalists are to the value of breeding research, which may mean so much to the future of the live-stock industry.

Continental Drift.

In the Geology Section, evidence which strengthens the argument in favour of the German investigator Wegener's much-disputed theory of the drifting of the continents—upon a basic substratum of the earth's crust, the sima—was brought forward by Mr. E. B. Bailey in a paper on the palaeozoic mountain systems of Europe and America. The published paper, with the diagrammatic maps of the two palaeozoic mountain systems, is an admirable summary of the history of some of the problems which geologists had to face in elucidating the very complex tectonic structure of those regions where some of the oldest mountains on the surface of the earth once stood.

The evidence is mainly gathered from those areas where the two mountain systems—the Caledonian and the Hercynian—are found to cross one another. The main conclusion is that the tectonic structure seen to begin in South Wales is completed in New England—the trend of the two chains cross one

another. The study made of mountain chains, with their folds and their thrusts which individually may be of the order of one hundred miles, involves a recognition of some type of continental drift. Of late years Wegener has developed this idea on a particularly grand scale. He has accounted for many recognized correspondences in the geology of the two sides of the Atlantic by supposing that the ocean has flowed in between the Old World and the New, as the two continental masses, with geological slowness, drifted asunder. One cannot help feeling that Wegener may perhaps be telling us the truth. The available evidence is crude and ambiguous; but it is certainly startling to be confronted on the coasts of Britain and America with what read like complementary renderings of a single theme: the crossing of Caledonian Mountains by those of the Hercynian system.

Evolution Problems.

The Presidential Address to the Zoology Section upon "The origin and evolution of larval forms," can hardly be said to have a popular appeal, yet the conclusions drawn are important for a true appreciation of the problems of evolution. Professor Walter Garstang cited both the theory of recapitulation and the theory of adaptation, and enlarged upon a standpoint distinct from, yet related to, both of these. He illustrated the following propositions in regard to trochosphere larvae with several examples:—(1) the larva has a double task to perform, *viz.*, to distribute the species and to grow up into the adult; (2) of these tasks the first is essential, and the second subsidiary—to be undertaken only so far as the larval resources permit; (3) the performance of the two tasks together requires the maintenance of an equilibrium between the locomotive efficiency of the larva and the adult weight to be carried; (4) the locomotive adaptation of the larva may proceed on new lines, paying no respect to phylogeny, and culminating in some kind of change of form; (5) the modification of the larva in this way need not affect the organization of the adult, since the casting of the most hypertrophied of ciliated girdles involves only slight processes of subsequent repair.

The early evolution of the "torsion" of one order of the gasteropods is put down to the effect of larval adaptation. The torsion is of prime importance to the larva in enabling the head and velum to be safely retracted at the first onset of danger. No intermediate "links" of the evolutionary process of torsion have been discovered—hence it is inferred that an adaptation of very obvious use to the larva was almost immediately adapted to the use of the adult. The development of the marginal slit of the gasteropod shell gives further evidence in support of the theory that adaptations in the first instance arise early in the individual life-history. "On purely morphological grounds I attempted to show that we are under no intellectual necessity of concluding that everything new must arise late in the life-history," Professor Garstang concluded.

Preservation of Scenery.

An interesting conference session, where delegates from many archaeological and natural history societies gathered together in consultation with the British Association, took place during the week. Dr. Vaughan Cornish delivered the opening address on the preservation of scenic beauty in town and country. The urgent need for a comprehensive regional planning of the Lake District was emphasized at a second session of the conference. Uncontrolled development must be rigorously opposed by planning on a systematic survey of the region, which must result in meeting the demands for increased accessibility and at the same time those for the preservation of its solitudes and its wild life.

The Great Barrier Reef.

The report of the committee on the expedition to the Great Barrier Reef was submitted to the Association. The expedition left England early this year, on 26th May, and Brisbane on 11th July. Dr. C. M. Yonge, Balfour Student of the University of Cambridge, is director of the expedition, and will undertake all research on the feeding and limestone formation of corals and molluscs, and economically on the growth and feeding of molluscs, especially the pearl shell. The expedition includes fourteen other members, two of whom are attached as geographers, and five of whom are Australians who joined the expedition at Brisbane. The work to be undertaken includes the study of the geology of the land and coast-line, of marine biology, and of the growth, feeding and reproduction of the organisms in the vicinity of Low Islands, near Cairns, where the expedition is encamped.

All collections, with the exception of that of bottom living plants, will be worked out systematically and morphologically by the members of the expedition, in association with the director and committee. The first set is to be deposited in the Natural History Museum, and the second offered to the Great Barrier Reef Committee.

The cost of the expedition has been estimated at £10,500, of which over £2,000 is still required.

Book Reviews.

The Creator Spirit. By CHARLES E. RAVEN, D.D., Canon of Liverpool Cathedral. (Martin Hopkinson. 8*s.* 6*d.*)

(Reviewed by Mr. Alfred Noyes, C.B.E., LL.D.)

Dr. Charles E. Raven, in his volume entitled 'The Creator Spirit," a survey of Christian doctrine in the light of biology, psychology, and mysticism, has made a real contribution to one of the great needs of the hour. A vast amount is being written at the present day on the foundations of religion in the light of modern thought, but the books that are of practical use to the seeker for truth, and are likely to bring any real illumination, are a very small and select band. Among them we must now place this volume, the sections of which were delivered as the Hulsean lectures at Cambridge and the Noble lectures at Harvard University.

Thirty or forty years ago the most striking characteristic of the conflict between religion and science (and in those days it was really a conflict), was the superiority in intellectual gun-power of the men of science to almost all of their theological opponents. With Darwin in command of the Grand Fleet of science, and Huxley taking the battle-cruisers into action, the antiquated ships of Orthodoxy, headed by the Ark, were sunk and battered into harbours from which they never emerged again into the open sea. But to-day there is a striking change in the situation, and the mere materialist who ventures to tackle any representative champion of idealistic philosophy, or indeed any competent theologian, in his own waters, is likely to be driven into an equally ignominious retreat. The "departmentalists" who have been engaged, on Victorian lines, in explaining away the higher values of life, have been hopelessly out-gunned. Nothing is more striking than the immense intellectual superiority, in range of thought, in grasp of philosophic principles, in clarity of logic, and in precision of statement shown by men like Dr. Gore, Dean Inge, Dr. Streeter, and now Dr. Charles Raven (all of them theologians), if their writings are compared with those of the merely materialistic men of science, who are perhaps more vocal than representative of their own great calling, at the present time. Interpreters of science like Sir Oliver Lodge and Professor Pupin are meeting the great idealistic philosophers more than half way in their refusal to be blinded (by the mere multiplicity of superficial detail) to the essential mystery that transcends reason, and cannot ever be *comprehended* by the reason, though man, being part of the same mystery, can *apprehend* it. Mere agnosticism is out of date.

But the materialist of to-day is as contented as the ostrich with the ignominious elevation of his tail in these matters. He delights to suppose that only the man who plants the cabbages of science is capable of thought. The hod-carrier of scientific "facts" is not only to supplant the architect, he is also to dictate the innermost beliefs of the man who is to inhabit the house; and, if this unfortunate being has any views of his own, based upon reasoning at least as valid as that of the hod-carrier, he is to be described as an arm-chair thinker, out of touch with reality. It is an interesting survey, from a new standpoint, that Dr. Raven has undertaken. He contends that, through the neglect of their own doctrine of the Holy Spirit, Christians have too often bound themselves more narrowly than was necessary within an ecclesiastical system, and that, in consequence, they have failed to interpret Creation as revealing the same values as their doctrines of Redemption and Inspiration.

He seems to over-estimate the extent to which science has shaken the belief of the best minds in the natural order as a revelation of God. To-day, as yesterday, the wisest saying that was ever appropriated by Lord Bacon remains true. A little knowledge leads men to atheism, but deeper knowledge leads them to religion. Unfortunately, the popular press seizes on every fatuous remark of the hod-carriers, and misleads the unscientific public as to the real state of affairs. London has recently been placarded with the statement "Science can create Life." In the scientific sense, of course, science cannot "create" anything. It can arrange, perhaps, and control the necessary material circumstances for the manifestation of life on earth, and that is all. The finest chapter in Dr. Raven's book is that in which he shows how the creative process (a process which Kelvin declared to be postulated, in the last analysis, by all true science, in all its departments), reveals its values. It appeals first to our sense of wonder; then to our sense of curiosity, by its order and design; and finally to our moral sense; the values thus disclosed being in harmony with the conclusion that the Spirit of God is the "Giver of Life," and leading on to the apprehension of the eternal reality behind phenomena. The passage in which Dr. Raven deals with the awakening of wonder, and the aesthetic values discernible in the natural order, is of remarkable quality.

"For me, and I think for many others, the immediate effect (of the impact of Nature) is sheer wonder—an awe which has in it both tears and laughter, both humility and exaltation. It is the poet that is fundamental in most of us—we are artists before we are scientists and philosophers—and the poet starts from the unity of the whole, not from the analysis of its parts. And as a poem the universe traverses the whole scale of our appreciation and satisfies every fibre of our being. . . . Here is art which breaks us with its terror, crushes us with its majesty, ravishes us with its joy, thrills us with its pathos, convulses us with its mirth; art in which thunder and mountains and harvest-field, snowdrop and centipede and puffin, octopus and antelope and little child have all their place; art perfect alike in its infinite variety and its balanced congruity. . . . And I see only a glimpse, I can measure but a fraction. Beyond my apprehension, too small, too great, lies marvel upon marvel. To watch the formation of crystals in the corpuscles in a drop of blood; to study the structure of a coral polyp, or the emergence of a moth from its cocoon; to feel the texture of a bird's feathers or listen to the thrushes at dawn; to trace the end of the rainbow or gaze at the rings of Saturn—that is the limit of my experience. . . . One needs eternity to tell the tale of it."

Dr. Raven's book is not the work of a departmentalist. In its combination of scientific knowledge with philosophic and religious insight, it should serve a great purpose at the present day.

The Romance of the Apothecaries' Garden at Chelsea. By F. DAWTREY DREWETT, M.D. (Cambridge University Press. 7*s.* 6*d.*).

In 1673 the Apothecaries' Company rented a plot of some four acres among the riverside pastures and market gardens of Chelsea to serve as an experimental garden for growing new medicinal plants and standardizing old ones. Their garden still remains to-day, an island of the rural London of the seventeenth century, unknown to most Londoners but not unvisited, for it has not achieved the melancholy distinction of a relic and show-piece of antiquity, but survives literally, living on robustly

in its old function of a scientific garden—a "Physic Garden" as its founders called it—and students are still working in its laboratories to-day, investigating the alkaloids of Henbane and the problems of grafting within sound of the motor buses of the King's Road, Chelsea. Its long active life has found a devoted and admirable historian in Dr. Drewett, whose book is a richly coloured picture of the great men—Sir Hans Sloan, Linnaeus, Sir Joseph Banks, and others—who were associated with the garden, of the everyday life of old (and modern) London, as well as of the garden itself with its old mulberry and persimmon trees and its beds laid out like "the pages of a living book on botany."

Dr. Drewett's book is not a mere chronicle of the dead past, but is as much alive as this garden, which, having given America its cotton and England its Cherrypie and Mignonette, is to-day distributing the seeds sent home by collectors in China and South America. The present edition is enriched by several new chapters and much curious learning, but is still all too short and it is to be hoped that its success may tempt Dr. Drewett to enlarge his field and to give us, perhaps, a book on the botany of everyday life or at least the "Treatise on String," of which he hints at the possibility when telling us about the Tamarisk bushes in the Chelsea garden and the rope of Tamarisk bark that was recently found at the bottom of a Roman well

F. A. H.

Mr. Blettsworthy on Rampole Island. By H. G. Wells. With a cover design by Sir William Orpen, R.A. (Benn. 7*s.* 6*d.*).

Many admirers of Mr. H. G. Wells in picking up his new novel will have retained from "The World of William Clissold" and "Meanwhile" a certain prejudice which not even an arresting cover design by Sir William Orpen can completely dispel. But when in the first few pages the reader is introduced to the "good broad Churchman," an uncle with whom Blettsworthy's boyhood is spent, the most biassed cannot fail to recognize the author of "Tono Bungay" and "The Time Machine" in his most pleasing vein.

It is true that the philosophy of the Rev. Rupert Blettsworthy is thrown into almost cynical contrast by its failure to influence the nephew when he found himself faced with reality; but that was mostly the fault of the nephew or his ancestry. Mr. Blettsworthy was born of a Portuguese mother, which may account for much of the weakness in his strangely lovable character. "At bottom we are all the same thing," the Rev. Rupert used to say. "Never get excited about forms or formulae. There is only one truth in the world, and all good men have got it." Darwin and Huxley he considered "sound Christians both, in the proper sense of the word. Honest men that is. No belief is healthy unless it takes air and exercise, and turns itself round and about and stands upon its head for a bit."

With such a background and an Oxford education, Mr. Blettsworthy experiences all too suddenly an unfortunate love affair and an equally disastrous experiment in business, which lead to a voyage round the world for his health. Next this "gentleman of culture and refinement"—so Mr. Wells describes him—is introduced to Rampole Island, as the result of a shipwreck; and here the doings of its cannibal inhabitants form a story reminiscent in the manner of its telling of Samuel Butler's "Erewhon." The records of anthropology surely contain no tribes more fascinating or more terrible than those here discovered, not least for the prehistoric Megatheria which still survive on the Island, age-old yet never dying. Blettsworthy had an intimate experience of the Megatherium in exploring its upland territories, where he was "roused from reflection by a flat loud bleating and a crashing of the undergrowth," and in fleeing away "could feel the hot reek of the pursuer's breath on his bare back."

By an accident almost as simple Blettsworthy escapes from the monster as afterwards from Rampole Island, returning to civilization in time to experience horrors in the War quite as devastating as any met with among the savages. Many recent writers have pictured war in all its nakedness, but none has shown the degradation and misery of it with greater effect than Mr. Blettsworthy, *alias* Mr. Wells. Even the opportunity which an eventful story provides for Mr. Wells's special talent does not allow him to escape completely from sociology, but the rather aggressive manner of some of his recent characters is more mellowed in Blettsworthy, and views are now seldom thrust at the reader.

To the least scientific mind the escape from Rampole Island proves exciting in its novelty, and to the psychologist Mr. Blettsworthy should provide an enthralling study. Much of the story is of scientific interest, and there are amusing details of this character, for example, the ship's engineer who "liked a *big* book about actual things."

"I had a book once," he related to Blettsworthy, "that told about the force in the tides and the waves. It's something terrific. There were calculations in that book. They went a little beyond me, but they were something striking. You could build a big tower and run all the trains in Europe and light almost everywhere with the force that wastes itself in one big blow like that. All gone to waste. Wonderful, eh?"

"Don't you believe it," said the mate. "You can't go against mathematics," said the engineer. "We live on the surface of things," Blettsworthy commented at this juncture

Though among the ship's company "nobody could find a handle on that remark," it will not be lost on the wider audience whom Mr. Wells always helps to get beneath the surface. And this time his friends will rejoice that he does so by telling a story—of the kind the Americans call "straight story."

J. A. B.

The British Sea-Anemones. By T. A. Stephenson, D.Sc. Vol. I. "Monographs of the Ray Society." No. 113. (London: Dulau & Co. Ltd.).

This delightful volume by Dr. Stephenson is a most welcome addition to British zoological literature. It is adapted not only to the needs of the specialist, but also to those of the ordinary lover of nature who spends some weeks of each year at the seaside. On every rocky portion of our coast there is no animal that more constantly obtrudes itself on our notice than the sea-anemone. Even in the most exposed localities where hardly any other form of life can endure the pounding of the billows the sea-anemone can be found clinging closely to the rock. Further, no marine animal survives better in aquaria than the sea-anemone, and so it is no wonder that this group of animals have always been favourites with amateur naturalists.

In the preparation of the volume under review, especially in making the paintings for the beautiful coloured plates which illustrate it, Dr. Stephenson has been largely aided by the work of his sister and his wife. From these plates the amateur may learn what the sea anemones really look like when alive, which is very different from the caricatures of themselves presented

by their contracted and distorted bodies preserved in the jars of a museum.

The author begins with a long and clear account of the anatomy of anemones, explaining carefully all the technical terms used in their description. In doing this he confers a benefit not only on the amateur but also on the ordinary zoologist. Zoology has grown into such a wide subject with such complexity in details, that the zoologist in dealing with the special anatomy and classification of a group, unless it be his own favourite one has little advantage over the amateur. Zoology is indeed by far the most difficult of all sciences; the technique, it is true, of physics and chemistry, is more difficult than that of zoology, but once the preliminary technique has been mastered, results are obtained with comparative ease and certainty. But zoology dealing with that mysterious and evasive thing termed life requires often from its followers a lifetime in order to answer conclusively a simple question.

The ground plan of the anatomy of sea-anemones is comparatively simple, and is taught to all elementary students of zoology. But Dr. Stephenson shows us with what infinite variation in detail this plan is worked out, and the same is true of their habits. Whilst the ordinary seaside naturalist supposed an anemone to be fixed for life to a definite position on a rock, Dr. Stephenson teaches us that all of them can and do move, that some burrow in sand and mud, and some even float upside down in water. Again, whilst the majority of them use their tentacles to seize prey, some get hold of their victims by currents produced by bands of cilia on the disc, and some by turning the gullet half inside out after the manner of a starfish. This gullet, by the way, has always been believed to be an intucking of the outer skin or ectoderm. Dr. Stephenson suggests that this time-honoured statement may be mistaken, and that the gullet may owe its existence to a concrescence of the upper portions of the inner ends of those folds of the stomach-wall termed mesenteries. In this we think that Dr. Stephenson shows himself to be too much of a radical. May we direct his attention to Dr. Duerden's description of the development of a coral polyp, in which he figures a stage in which the stomach is represented by a mass of yolky cells not yet hollowed out, whilst the gullet is already an open tube in continuity with the outer skin or ectoderm and lined by a similar epithelium?

The volume which we are considering deals only with British anemones—and only, indeed, with half of these. We shall look forward to the publication of the second volume with interest and anticipated enjoyment.

E. W. MACBRIDE.

Problems in Psychopathology. By T. W. MITCHELL, M.D. (Kegan Paul. 9*s*.).

The author insists that study of the body has always been bound up with the study of the soul, and in his first chapter he gives a survey of the state of the science of psychology before the epoch-making advent of Freud, with particular reference to the knowledge of the forces at work in the production of hypnotic suggestibility and hysteria. Freud's new method of investigating the human mind followed up Breuer's discovery that symptoms of hysteria are related to forgotten events in the past life of the patient, and that the symptoms disappear if the events can be restored to memory. Dr. Mitchell discusses Freud's psycho-analytic theory of the neuroses, and devotes separate chapters to the explanation of what is meant by the terms *libido* and *ego*, showing that it is fear of the libido, expressed by the ego, which gives rise to the phenomenon of repression and the formation of neurotic symptoms.

Since it has been in the endeavour to formulate a consistent theory of the neuroses that medical psychology has made its most important contributions to general psychology, the author discusses the various theories, from Hippocrates to the present day, beginning with Plato's idea that the organ of generation becomes rebellious and seeks to gain absolute sway. Though Plato's theory of an "angry womb wandering through the body" is, of course, impossible of literal acceptance, he recognized the connexion between hysteria and the sexual life which Freud was the first in recent times to proclaim openly, the teachers of medicine before his time having apparently lacked the courage to communicate their knowledge even to their own pupils. The word "hysteria" comes, in fact, from a Greek word meaning "womb."

This volume appears to be based on a series of lectures delivered before the British Institute of Philosophical Studies, to an audience consisting, from the point of view of the psychologist, of laymen. They should, in book form, provide a wider public with a useful introduction to medical psychology and psycho-analytic theory, the value of which is enhanced by a summary of the concepts of post-Freudian medical psychology, such as those of Jung and Adler, which vary from the tenets of the master.

W. R.

The Social World of Ants. By DR. AUGUSTE FOREL. Translated by C. K. OGDEN. Two volumes. (Putnam. 63*s*.).

To the entomologist the name of Auguste Forel is well known as one of the leading authorities upon ants and as the author of "The Senses of Insects," but entomology is only his hobby. He is a well-known mental specialist in Switzerland, and is also a sociologist, having written a book upon "La question sexuelle." In the preface to this two-volume book of nearly one thousand pages, he mentions that he is seventy-eight years of age, and speaks of this as his last work. It is the result of more than seventy years study, as he tells us that he made his first observation upon slave-making ants at the age of seven and a half.

The book is charmingly written for the general reader, is couched in the most simple terms and, whenever a difficult scientific word is used, an explanation in brackets follows. The subject of ants is exhausted, chapters or sections dealing with structure, classification, geographical and geological distribution, physiology and habits, the industries of ants, and their relations with plants and animals. All this comes in volume 1, while volume 2 deals with the relations between different kinds of ants, followed by an "epilogue" which is almost the only part of the book in which the author lets himself go upon debatable subjects. At the end is an appendix by Professor Bugnion upon "The War between the Ants and the Termites: a Study of the Origin of Instinct," which has also been published separately and of which a review appeared in *Discovery* for September.

As a whole the work is a masterpiece, and criticisms are of a minor character. The earlier chapters are, in places, out of date, the terminology dating back to a time before entomology became a science. Dr. Forel describes the ant larva as being composed of "about twelve segments," and speaks of the "epinotum" as the fourth part of the thorax, saying that it is "more or less peculiar to ants." He refers to "adelphogamy" as unique in ants, although it certainly occurs in chalcids and

probably elsewhere. He describes the maxilla as the jaw, which he distinguishes from the mandible, and calls the ligula the "tongue." He states that the spermatozoa, on copulation, are "forced" into the spermatheca. On page 15 he states that "polymorphism in ants takes place in the egg," whereas on page 25 he says "we do not know where and when the differences between the polymorphic individuals begin" and, referring to a particular case, "here it is evident that differentiation must begin at a very early stage in the larva, if not actually in the egg." As a fact evidence seems to indicate that the caste is determined after the emergence from the egg, and it is even possible that sex may be reversed at this stage. Dr. Forel says that "terrestrial animals which are not able to endure the tropical climate cannot cross the equator unless they are borne by a swift steamship" (page 9), having apparently forgotten the possibilities of the mountain ranges. He suggests that the worker ants feed by endosmosis the developing embryos in the egg (page 21), although he mentions no evidence in favour of this view.

So far as the printing of the book is concerned, there are one or two mistakes. On page 23, an asterisk below figure 1 refers to a footnote, which says, "For the explanation of all these figures see the end of the Volume." As a fact, the explanation of figures is at the beginning of each volume. The references to figures or plates in the text often refer to the other volume, which is very inconvenient, if perhaps unavoidable. But the two volumes are beautifully got up, and both the translator and the publishers are to be congratulated upon it, not only as an ornament for the library but because it is a really good book.

FRANK BALFOUR BROWNE.

Music. By URSULA CREIGHTON. Illustrated (Chatto & Windus. 7*s*. 6*d*.).

For the second time within the space of a few short months a volume on musical history has appeared with the laconic title "Music." Sir W. H. Hadow's compression of nearly twenty centuries of musical history into six chapters had this single-worded description attached; the reason why its successor, Mrs. Creighton's book, is similarly entitled, is explained by it forming one of "The Simple Guide Series" of modern knowledge in science and art, and the title consequently, is merely indicative of the subject handled. Its scope may be inferred from some of the chapter headings, such as, "Early Music," "Polyphonic Music in England and on the Continent," "The Beginnings of Opera," "Bach and Handel," "Italian Opera," "Wagner," and "Some Modern Composers."

Obviously, in a short volume of some 250 pages, it is inevitable that a good deal should be left unsaid. But compensation for this concession to space demands is found in the demonstration that things, apart from persons, can be full of interest. It tells us less of prima donnas and pyrotechnics and more of the evolution of melodic forms and changes of harmonic fashion; although when dealing with the personal aspect three and a half pages devoted to Paganini (who contributed nothing to the advancement of the creative art) and only eight lines to Elgar is sufficient to cause more than a raising of the eyebrows. There is nothing of the hastily thrown together or slovenly written about this book, however; its subjects are discussed lucidly and closely. It is a pity "rhythm, melody and harmony" should have been printed and examined in that order, when the proper sequence in which to consider these elements is melody, harmony and rhythm. Music consists of tones heard in succession as in melody or simultaneously as in harmony; rhythm is that property of the one or the other, or both, which is dependent on time, but it does not take precedence. It is well, therefore, that before the author concludes her examination she concedes that "Melody is to us the essence of music."

H. H. W.

The Book of Remarkable Machinery. By ELLISON HAWKS. (George G. Harrap & Co. Ltd. 7*s*. 6*d*.).

From the wealth of material available for a book on this subject, the editor of the *Meccano Magazine* has ably compiled a short history of mechanical inventions from the time of the advent of steam power. There is a long story to be told from the time of the experiments of Newcomen and Savery to that of the work that perfects the modern calculating machine; yet the author has set out in an interesting and non-technical style the evolution of the machinery in use in several trades—including the iron and steel and the printing industries. The steam engine, the internal combustion engine, and the machinery on board ship are all described from their first simple beginnings in a way that attracts the attention of the non-mechanical mind.

The World in the Past. By B. WEBSTER SMITH. (F. Warne & Co. Ltd. 10*s*. 6*d*.).

The numerous well-chosen illustrations, many of them coloured, give this volume in the "Wayside and Woodland Series" an additional popular interest. The story of the geological ages is preceded by an introductory account of the importance and manner of operation of the chief agents of denudation which have acted upon the earth's surface throughout the ages until the present time.

As the title implies, the account given of the past covers a world-wide area. Thus the lay reader, for whom this book in the first place is intended, will not fall into the general error of expecting the geological classifications and history of north-western Europe to be world-wide in their application.

Perhaps undue importance has been given to the recent Ice Age which in geological reckoning was relatively an insignificant portion of Earth history. The popular interest in this more recent epoch may, however, fully justify the detail of this section of the book.

A. R. E.

David Livingstone, Explorer and Prophet. By CHARLES J. FINGER. (George Allen & Unwin Ltd. 7*s*. 6*d*.).

The author has no new material to add to the wonderful story of David Livingstone—his magnetic personality or his great discoveries, epoch-making in the history of the interior of Africa—but he brings out their value in a fresh and illuminating way. He himself, intensely interested in one or two of the more widely-known adventures of the famous explorer, went back to the original journal, *Missionary Travels*, and read for himself the explorer's own account which is so little known. He rewrites the story in a characteristic style which is easy to read.

The book should go far to disprove the impression of Livingstone in the mind of many as "a rather uninteresting fellow doing nothing more than preaching and going about with a Bible under his arm," and to demonstrate the true magnitude and worth of his discoveries.

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